

Part I Master Plan Study

E.1 PRESENT CONDITIONS OF THE STUDY AREA

E.1.1 Land Use and Soil

(1) Land Use

1) General

The Study Area covers about 1.2 millions hectare, which includes five provinces, namely Kratie, Kampong Cham, Kandal, Prey Veng and Takeo. The concerned five provinces occupy about 18 % of national land, 33,359 sq. km. On the other hand, about 40 % of agricultural land, 15,624 sq. km., exists in the five provinces in 1992. Among those five, Kampong Cham has the largest farmland, 5,218 sq. km. Except for Kratie, the agricultural land is increasing in other four provinces for recent 20 years. In particular, about 90 % of provincial land now becomes agricultural land in Prey Veng (see Table E.1.1, Figure E.1.1 and E.1.2).

In 1994, 42 % of national population live in the five provinces. Kampong Cham has the largest population, about 1.5 million people, which represents 15 % of the nationwide population.

2) Agro Eco-System Map

Agro-Ecosystem Map drawn by LUMO, MAFF, shows that the Study Area is covered by nine major units of vegetation. Six of them are defined as agricultural land and three of them are as forest land. About 62 % of the Study Area is classified into agricultural land and about 33 % is classified into forest land. Remaining area is composed of river and lake.

Among the five provinces which included in the Study Area, three quarters of the provincial area in both Takeo and Prey Veng are occupied by agricultural land. In Kampong Cham and Kandal, almost half of the area is represented to agricultural land. Kratie has the least agricultural land occupation, 27 %. About 10 % of area in Kratie, Kampong Cham and Kandal provinces are presented in river and lake (see Figure E.1.3, Table E.1.2 and E.1.3).

Based on the remote sensing analysis data, the land under agricultural utilization occupies 41 % of the Study Area. This figure is lower than the data obtained from Agro-Ecosystem Map. There are several possible reasons for this discrepancy. The photo images were taken in January and February, 1995, but the map was drawn in late 1980s, so, firstly, the actual land use may change during this period. Secondly, the remote sensing analysis includes more legends (12 legends) than Agro-Ecosystem Map (9 legends) so other legends such as waste land, grassland, may include some areas that were classified into agricultural land by Agro-Ecosystem Map (see Figure E.1.4).

3) Agricultural Land

The agricultural land use situation in the Study Area is decided by natural conditions, particularly in wet season. During the period of high flood water level, the land is widely covered by flood water. The duration and the depth of flood varies by location but vast inundated area can not be utilized. The huge flat areas of the northern and middle part of Prey

Veng, the north-west part of Kandal and the north-east part of Takeo receive shallow and short-period flood. Rainfed paddy cropping is the main activity in those areas.

On the other hand, during dry season, from November to April, the availability of irrigation water is a vital factor for agriculture. Generally, these farming areas are located along the Mekong and the Bassac and around lakes (boeng). There are some areas where irrigation systems are constructed, such as Kampong Sne, Prey Veng, but not common.

As described above, Agro-Ecosystem Map, shows that about 60 % of the Study Area, 739,000 ha, is classified into agricultural land. Wet season paddy area occupies the largest distribution 71 % of agricultural land and followed by cereals and annual crops; 14 %, floating rice; 9 %, dry season paddy; 4 %, and rice and cereals; 1 %.

The results of remote sensing analysis indicate relatively small area (about 476,000 ha) for agricultural land which comprises dry season paddy, wet season paddy, upland crops, and plantation. This area difference may come from the interpretation of photo images for idle land area; waste land, grass land and swamp, which is not shown in Agro-Ecosystem Map. Another difference between two analyses is the distribution of each item. Dry season paddy area of remote sensing analysis is further bigger than that of Agro-Ecosystem Map (see Table E.1.4).

In terms of the land use, the Study Area is roughly divided into two categories, the flooded area and the non-flooded area. The no-flooded area is comprised from city/town/village area and river banks. The flooded area is classified into two sections; rainfed paddy area and waste flooded area. With the rising up of the water level of flood from the Mekong, the flooded area spreads over. Waste flooded area is broadly distributed along the back swamps of the Mekong and Bassac river from Kratie to Kandal. Some of this area is utilized as agricultural field for dry season farming such as recession rice or field crops.

With the increase of rainfall in wet season, the flat land where remains waste during dry season gradually changes to agricultural land. Preparation of the seedling beds and first plowing for wet season paddy are commenced on the lowland where rainfall water tend to stay.

The river banks of the Mekong, Tonle Sap and Bassac rivers are usually never flooded or are flooded only for short period, so they are usually utilized for upland crop fields. In the suburbs of Phnom Penh (along the national highway 6A, both river banks of the Bassac and the Mekong), vegetables are broadly cultivated and supplied for capital residents.

(2) Soil

1) General

Systematic soil surveys in Cambodia started in the early 1960's. The classification of the nation's soils based on the 1938 USDA soil taxonomy was presented by Charles Crocker (1963). Subsequent soil studies were generally based on Crocker or were translations of Crocker's study to other classification system.

Based on the Soil Map prepared by LUMO, MAFF, the Study Area comprises eleven soil units. Alluvials, Cultural Hydromorphics and Brown Alluvials are the dominant soil units and each soil

unit covers 55, 18, and 12 % of the Study Area. The general characteristics of these soil units are as follows;

13. Alluvials

The fresh-water alluvial deposits, bordering the rivers, especially the broad alluvial flats of the Mekong, are geologically recent deposits of effluents in which pedological processes of soil formation have not proceeded enough to make significant pedological horizon differentiation.

5. Cultural Hydromorphics

Soils which have a thin, artificially compacted, impermeable horizon resulting from development into paddy fields. While these soils are classified on the basis of recent cultural usage, the shallow impermeable compacted layer of the soil has an overriding effect on the physical and production characteristics of these soils.

14. Brown Alluvials

Coarser-textured soils along the Mekong and Bassac rivers banks and islands. They are economically quite significant and have different production potential from the finer-textured slake-water alluvials of map unit 13, which are usually farther back from the river channels.

With good farm management, high yields of paddy are generally expected on those three units. Acid sulfate soil, which is partially observed in the tropic and becomes one of the agricultural constraints, is not distributed in the Study Area (see Figure E.1.5 and Table E.1.5).

2) Nutrient Supply Effect by Flood

The coarse silt conveyed by flood is generally deposited when the flow velocity rapidly decreases. The colmatage systems existing broadly along the Mekong and Bassac rivers in Kandal utilize this phenomenon to make lowland level lift up and turn it to farmland. Based on the farmers' interview at some colmatage systems along the Bassac in Kandal, there is annually 20 to 25 mm silt accumulation. Primarily, colmatage system aims to make lowland high by deposited silt. From the viewpoint of plant nutrients, silt accumulation seems to have positive effect on agricultural productivity.

To grasp the influence of nutrient supplied by the flood of the Mekong, fourteen soil samples were collected and analyzed in twice. Eight soil samples, including two controls, were collected from both left and right banks of upstream, middle and down stream along the Mekong, which receive severe annual flood. Six samples were collected from both banks of upstream, middle and down stream away from the Mekong, which receive less severe annual flood. First analysis was conducted by the Study Team with portable soil nutrient tester adopted colorimetric method and second one was done by Soil Laboratory, DOA, MAFF (see Figure E.1.6).

It is expected that clay/silt distributions have difference between the two groups, because the areas along the Mekong are flooded longer period than the other so it is presumed that those areas receive more clay/silt accumulation. And this may induce the differences of some pedological features such as cation exchange capacity, exchangeable cation contents, etc. But

both two analyses indicate that there is no significant difference for all items between two groups; the soil samples along the Mekong and those away from the Mekong. Only one item of portable tester analysis, exchangeable potassium, shows significant difference between two groups at five (5) % level (see Table E.1.6 and E.1.7).

In the past studies, there were two kinds of results. One report suggests that the soil samples collected within the zone of flooding in Kandal and Prey Veng are considerably richer on available potassium, magnesium, calcium and phosphorus (J.V.Dennis Jr., "Kampuchea's Ecology and Resource Base : Natural Limitations on Food Production Strategies"). But there is also another report that says there is no difference of the phosphorus, nitrogen and manganese contents between the near Mekong River Delta bank and far away Mekong River Delta bank in Viet Nam (University of Hawaii, "The Comparison of Mekong River Silt and its Possible Role as a Source of Plant Nutrient in Delta Soils", Mekong Committee, 1985).

Although there is not clear difference between two groups in terms of nutritious contents, yet the number of analyzed samples is very limited. Moreover, the farmers along the Mekong, Bassac and Tonle Sap rivers generally know that flood water and sediments bring better harvest from their experiences. Therefore it can not be concluded that the soils along the Mekong do not contain more soluble nutrients than the soils away from the Mekong.

E.1.2 Agriculture

(1) Position of the Study Area in Cambodia

1) Food Balance

From the viewpoint of national food balance, the official statistics show that Cambodia could not support enough food by itself in both 1992/93 and 1993/94. Although national food self-sufficiency is achieved in 1995/96 (Agricultural Statistics 1995, Department of Planning and Statistics, MAFF), regional and localized shortage in rice still exists due to security problems and poor transportation conditions.

At the provincial level, there are two provinces in the Study Area, namely Prey Veng and Takeo, which provide enough food for provincial demand in 1993/94 and 1995/96. Other three provinces basically can not attain self-sufficiency (see Table E.1.8).

2) Paddy

Based on the official statistics published by Department of Planning, Statistics and International Cooperation, MAFF, the five provinces occupy more than 40 % of paddy harvested area and paddy production. Generally, wet season paddy is more important than dry season paddy in terms of both area and production. But the average yield of dry season paddy is generally higher than that of wet season paddy, so the production of dry season paddy represents about 16 % of total paddy production in comparison with 9 % of cultivated area in 1992.

The five provinces occupies more than 80 % of the whole dry season paddy cultivated area and the dry season paddy cultivated area has increased in the four provinces, namely Kampong Cham, Kandal, Prey Veng and Takeo, during these 10 years. In Kandal, the ratio of dry season

paddy is generally more than 40 % of total and that makes the average paddy yield higher than those of the other four provinces, 2.06 to 3.18 ton/ha for 1992/93 to 1994/95. The average paddy yield of the other four provinces, that the ratio of dry season paddy is lower than 20 %, varies from 1.16 to 1.75 ton/ha for the same period (see Table E.1.9 and Figure E.1.7).

3) Upland Crops

In comparison with paddy, upland crops are cultivated with relatively small scale. Among all upland crops, maize, mung bean, tobacco, cassava and sesame are the five largest crops of harvested area in 1994/95 in Cambodia. Vegetable statistics, such as Chinese cabbage, green pepper, carrot, long bean and so forth, are not available at present. Because they are not counted separately by each crop but counted as a whole, just vegetables. Only the national data are available.

Maize was once cultivated in more than 100,000 ha and the production was more than 100,000 tons in 1980/81. These several years, the cultivated area varies from 40,000 to 50,000 ha and the production varies from 45,000 to 60,000 ton. The five provinces occupy 72 % of harvested area and 76 % of production. Both national and provincial yields change to parallel with year, from 1.96 ton/ha in 1989/90 to 1.06 ton/ha in 1993/94, so it means that the climate conditions largely fluctuate the maize productivity every year. Yet each provincial yield still remains low level (see Table E.1.10 and Figure E.1.8).

Mung bean is the second largest field crop in Cambodia. Also same as maize, mung bean was cultivated more than 40,000 ha and produced more than 20,000 tons, but in recent 6 years, the cultivated area varies from 20,000 to 30,000 ha and the production varies from 10,000 to 17,000 tons. Among the five provinces, Kampong Cham produces 43 % of whole production in 1994/95. The other four provinces in the Study Area produce 24 % of whole production. It means that about 70 % of national mung bean production come from the five provinces. Generally, 70 % of mung bean was cultivated in wet season. But in both Kandal and Prey Veng, dry season cropping becomes familiar in 1993/94 and 1994/95. The yield varies 0.40 to 0.80 ton/ha (see Table E.1.11 and Figure E.1.9).

Tobacco is popularly cultivated as a dry season crop. The five provinces occupy 98 % of whole production and Kampong Cham represents 66 % of it in 1994/95. In 1993/94, both production and harvested area sharply dropped due to the decrease of cultivated area in Kampong Cham. But as a whole, both production and cultivated area has been increasing for last 14 years. The yield varies 0.5 to 0.8 ton/ha except for Prey Veng. The yield in Prey Veng was relatively low before 1992/93.

Both cassava and sesame are cultivated around 10,000 ha in recent years. As for the Study Area, sesame is more important because the production share of the five provinces is more than 80 % of total, for cassava 51 % share. In Kandal, cassava is largely cultivated in dry season, but in the other four provinces, wet season cropping is usual. Also sesame is mainly cultivated in wet season, but in 1994/95, dry season cropping increases in both Prey Veng and Kampong Cham.

Soybean is one of the exporting products for Cambodia, and Kampong Cham is the production center that occupies 91 % of production in 1991/92. As for fruit trees, there is no official statistics so it is hard to grasp the present situation of production and planted areas of matured trees.

4) Animal Husbandry

After 1980, all animals; cattle, buffaloes, pigs, poultry, draught cattle and draught buffaloes, have been gradually increasing. Animal raising is generally not commercial base but under small scale. Large animals such as cattle and buffaloes are mainly raised for draught and small animals such as pigs and poultry are mainly raised for supplementary income of farmers. Preliminary farm interviewing survey actually shows that most of farmers who can afford to raise pigs or poultry have small animals for the source of cash income (see Table E.1.12 and Figure E.1.10).

(2) Planted Area and Production

From the five provincial agricultural offices, production and area data of paddy and five major upland crops in each province were collected. The five major upland crops were selected by provincial staff so the data of some crops are not completed for five province. Collected data are modified with the district area distribution of the Study Area to suppose the agricultural production of the area (see Table E.1.13, E.1.14, E.1.15, E.1.16, E.1.17, E.1.18 and E.1.19).

Share of natural area distribution of the Study Area of five provinces is only 37 %. Both paddy area and production of the Study Area occupy more than 60 % of whole five provinces data, in particular, about 80 % of dry season paddy production comes from the Study Area. This tendency is strong among four of five upland crops except for sweet potato. Dry season cropping of the Study Area represents 79 to 95 % of production and 85 to 94 % of area, respectively.

Yields of both wet and dry season paddy of the Study Area are 4 % higher than the yields of five provinces. Yields of vegetable and sesame are lower, but those of maize, mungbean and sweet potato are higher than the yields of concerned provinces. Yield of wet season mungbean is 78 % higher than the yield of five provinces.

From the Rural Socio-Economic Survey (referred to "Appendix-H Rural Sociology / Operation and Maintenance of Facilities"), average yield of wet season paddy is calculated as 1.47 ton/ha. The average yield of Prey Veng is the lowest, 1.12 ton/ha, among the averages of five provinces and this is attributed to low productivity, less than 1.0 ton/ha, of some districts located away from the Mekong, such as Kanh Chreach, Prey Veng and Kamchay Mear. In terms of dry season paddy, average yield is calculated as 2.77 ton/ha. Both Kandal and Takeo have the higher average than that of the Study Area. Those two yields from the Rural Socio-Economic Survey are lower than the yields calculated from provincial statistic data, 1.75 ton/ha in wet season and 3.43 ton/ha in dry season. Some FAO report indicates that forecasts made by farmers are generally understated and this discrepancy between two yields data may be caused by farmer's understatement.

The two third of the farmers who practice only wet season paddy feel that the paddy production is not enough for them, particularly in Kampong Cham. Those figures of dry season paddy practicing

farmers are lower than that of only wet season practicing farmers and this may come from the result that the average yield of wet season paddy is lower than that of dry season paddy.

(3) Farmers and Farmland Holding

According to the Rural Socio-Economic Survey, 872 farmers are land owned ones among 900 interviewed. Less than 3 % of them (25 farmers) are tenant farmers and three farmers are unknown (see Table E.1.20).

Average area of titled land is 1.19 ha but five provincial averages vary from 0.78 ha in Kampong Cham to 2.07 ha in Takeo. About half of farmers in Kampong Cham have titled land less than 0.90 ha but 45 % of farmers in Takeo have titled land more than 1.80 ha (see Figure E.1.11).

Land owned farmers are also divided into two kinds, 855 paddy practicing farmers and 17 not paddy practicing farmer. Following analyses are basically based on the 855 paddy practicing farmers who represent 95 % of all respondents.

From the viewpoint of paddy practicing season, 855 paddy practicing farmers are classified into three types, namely, 232 wet season paddy practicing farmers (27 %), 326 dry season paddy practicing farmers (38 %) and 297 both wet and dry season paddy practicing farmer (35 %). Only in Kampong Cham, wet season paddy practicing farmer is the largest of the three types. On the other hand, dry season paddy practicing farmer is dominant in Kandal where most land is flooded in wet season. The histograms of titled land area by the three farmer types of paddy practicing season are analyzed but they are almost same. It means that the provincial difference of titled land area is bigger than that of the farmer types of paddy practicing season.

In terms of upland crops, 452 land owned farmers practice some upland crops, which represents 52 % of land owned farmers. Generally, dry season paddy practicing farmer has high introducing ratio of upland crops, about 70 %. On the other hand, only one third of wet season paddy practicing farmers introduce upland crops. The ratio of both dry and wet season paddy practicing farmer is intermediate, 45 %, but only in Kandal, about 70 % of them introduce upland crops. In Takeo, only one quarter of all farmers introduce upland crops, but in other four provinces, about half of farmers introduce them (see Table E.1.21).

(4) Crops and Farming Practices

Based on the results of the Rural Socio-Economic Survey, 36 crops are cultivated in the Study Area except for paddy. Five common upland field crops are maize, cucumber, mungbean, tobacco and sesame. Among them, maize is the most popular field crop in the Study Area, which is cultivated by 264 farmers (58 % of upland crop practicing farmers). Cucumber is broadly cultivated in the Study Area but tobacco and sesame are cultivated mainly in Kampong Cham and mungbean is mainly in Kandal.

Average number of practicing upland crops per farm in the Study Area is 2.0 crops and this is derived from the fact that three quarters of upland crops practicing farmers perform one/two crops farming except for paddy. One farmer in Prey Veng practice seven upland crops but the farmers who practice more than three upland crops are few in the Study Area (see Table E.1.22).

There are nine main cropping patterns of wet season paddy in the Study Area as shown in Figure E.1.12. Among them, dominant patterns in the Study Area are W-2, W-3, W-5 and W-6. Total of W-5 and W-6 represents 39 % and that of W-2 and W-3 represents 26 %. There are also nine main cropping patterns of dry season paddy. Dominant patterns in the Study Area are D-3, D-5, D-6 and D-8, and those four patterns count for more than 60 % of all. In the Study Area, there are some farmers who practice double cropping of paddy but it is limited only for those who can secure enough seedlings and irrigation water all year round.

In the Study Area, the majority of wet season paddy is traditional variety. There are 61 wet paddy varieties and medium/late duration varieties are dominant. Variety "bonla pdau" is the most popular variety in wet season and 24 % (127/529) of wet season paddy farmers cultivate it. On the other hand, IR varieties are common for dry season and more than 80 % of dry season paddy practicing farmer use them. IR 66, IR 36 and IR 42 are three the major varieties and these three varieties count for 480 out of 623 dry paddy practicing farmers (see Table E.1.23).

Generally, each farmer keep rice seed by himself. According to the Rural Socio-Economic Survey, 94 % of paddy practicing farmers (784/835-20 farmers are unknown) use self keeping rice seed customarily. Governmental rice seed distribution does not seem to function well.

It is said that the Cambodian agriculture is generally extensive but the farmers in the Study Area usually use fertilizer. The Rural Socio-Economic Survey shows that those who use fertilizer represent 82 % of paddy practicing farmer (674/821-34 farmers are unknown) and in Takeo every farmer uses it. Urea and 16-20-0 are common fertilizers. Applying agricultural chemicals, particularly insecticide, is also familiar among dry season paddy farmers in the five provinces. Methyl-parathion and Monocrotophos are commonly used (see Table E.1.24, E.1.25 and Figure E.1.13).

Farm labor entirely depends on manual works and draught animals. On the average, a farmer has 4.25 agricultural labors (2.05 men and 2.20 women) and two draught animals including calves, but 20 % of paddy practicing farmers (171/855) do not have any draught animals and 96 of them rent draught animals from others.

Among 855 paddy practicing farmers, only 36 farmers (4 %) responded that they had their own agricultural machines but they are all limited to mobile pumps for irrigation. Generally, irrigation is conducted by traditional manual method called *snaich* or *rohat*. But interview of farmers shows that some farmers rent mobile pumps from others. A few rich farmers own 4-wheel tractors and provide tractor plowing as contract work but the number of tractor is still very small.

During dry season, farming such as dry season paddy, upland crops, is limited only in the areas where water is available. Generally, these areas are distributed along the Mekong and the Bassac and around lakes (*boeng*). There are some areas where irrigation systems are constructed, such as Kampong Sne, Prey Veng, but not so usual. In Ksach Kandal, some farmers install pumps on the river bank of the Mekong and irrigate dry season paddy field. They conduct double cropping of paddy.

The wet season farming is generally accounted to two main activities. One is wet season paddy, and the other is upland crops. The Rural Socio-Economic Survey indicates that seven among surveyed 37 districts are dominated by the farmers who practice only wet season paddy (excluding both wet and dry paddy practicing farmers). In several districts, the occupation of only wet season paddy practicing farmers exceeds more than 80 %; Kanh Chreach in Prey Veng, Ang Snourl and Kandal Stung in Kandal.

(5) Livestock

Livestock still plays a vital role in the farming system and meal in Cambodia. Generally, most of farmers depend on draught animals, cattle and buffalo, for cultivation and transportation. Livestock such as beef, pork, chicken is the important animal protein source for Cambodian people as well as fish. It is estimated that total annual animal protein consumption per capita is 26.4 kg, and more than half of it comprises livestock, 8.5 kg of pork, 3.3 kg of beef and 2.8 kg of poultry.

A pair of bullocks is used for cultivation and harrowing works. Some 15 to 20 days are necessary to prepare one hectare of paddy field by a pair of bullocks. Hariana of the Indian cattle, which is generally called as Zebu, is popularly used for draught works.

Major sources of feed for cattle are wild grass for wet season and paddy straw for dry season, and stubble grazing is also practiced after harvesting paddy. Cattle manure is used as the important natural fertilizer. Pig fattening and chicken raising are popularly observed in rural areas but in small scale.

The number of draught animal per one hectare of paddy field in concerned five provinces is as follows: Kratie - 0.5, Kampong Cham - 1.2, Prey Veng - 0.5, Kandal - 0.9 and Takeo - 0.8 (head/ha). Those figures are insufficient and price of bullocks is quite expensive for poor farmers. Some agricultural institutions provide draught animal loan and cow bank by lending adult cow to farmers with feed for calves. National Cattle Breeding Center in Takeo, which is managed by the Department of Animal Production, MAFF, provides about 100 cattle every year to meet demand but it is not yet enough.

(6) Forestry

The data obtained from Agro-Ecosystem Map, LUMO, MAFF, show that about 33 % of the Study Area, 387,000 ha, is classified into forest land, which consist of bush, inundated forest and forest. Vast bush lies between the Mekong and the Bassac rivers. Inundated bush is largely distributed to Prey Veng, Takeo and Kandal. Kampong Cham occupies more than three quarters of whole forest in the Study Area. For Cambodian economy, logs and sawn timber are one of the major exports these years, but they are not produced in the Study Area.

Those forest areas have several important roles for rural people. They provide firewood for energy supply and the material for houses. The infrastructure conditions, electricity and gas, in rural areas are poor, so that rural people need to use firewood continuously. Another important function is environmental one, regulating flood water from the Mekong and the Bassac rivers. Inundated bush has a function of hatchery for fish, too.

(7) Women in Agricultural Activity

So far, it is said that woman labor has a great role in Cambodia resulting from long civil war. From the Rural Socio-Economic Survey, average agricultural woman labor per farm is larger than that of man labor although the difference is small. Among 855 paddy practicing farmers, those who have more man labor than woman labor represent 26 % but those who have more woman labor than man labor represent 36 %. This tendency is common among three types of paddy practicing farmers but in two southern provinces, Kandal and Takeo, woman labor for agriculture seems to have greater role than other three provinces (see Figure E.1.14).

Half of daily working hours of woman are still dedicated to farming practices. Women usually do not work for plowing or harrowing which needs draught animals but work for transplanting or harvesting.

(8) A Thorny Plant, *Mimosa pigra*

Thorny bushes are found here and there in the flooded area where the lands are abandoned or intact. The plant is highly dominant in the flora, though the flora is often mixed with reed or some other plants. The plant is called in Khmer, "Banla youm" (Vietnamese thorn), "Banla Polpot" (Polpot thorn), "Bang Trap Thom" (Big river thorn tree), or "Uya" (Shouting voice). All of the Khmer names imply an unfavorable plant, because the plant is not useful or even harmful to human life. The steering committee of the study picked up the plant as one of problems to reclaim the lands. It is also taken up in WETLAND ACTION PLAN FOR THE KINGDOM OF CAMBODIA (draft), 1995, that there is a danger *Mimosa pigra* may out-compete local species, thereby reducing the ability of flooded forest to regenerate. Botanically the plant falls under *Mimosa pigra*, LEGUMINOSAE. The plant originated in South America, thus it is an exotic plant in Cambodia. *Mimosa* is reputed of *Mimosa pudica* L., sensitive plant in English which closes the leaves and the petioles quickly when it is touched.

The plant is bigger in size than *Mimosa pudica*, 2 m to 3 m in height and it is standing slant while *Mimosa pudica* is short and somewhat a creeper. The branches are brown, many, irregular, long, and 5 mm to 10 mm across. Strong thorns are between the petioles, on the feather axis, the branch, and the trunk which is not big in size. A petiole has 7 - 9 pairs of feathers, and sometimes a feather at its end. The leaves are green, small, attached opposite and 34 to 43 pairs of leaves on a feather petiole. The leaves and the feather petiole close when they are touched, but the petiole itself does not close unlike *Mimosa pudica*. The flower is pink, looks like a ball, similar to that of *Mimosa pudica* but larger in size. The pod is light brown, has many strong hairs on it, shapes like a sickle, and several pods (2 to 7 pods) are fruited on a petiole. The pod has a distinct character that it has a string surrounding seeds holding 15 to 17 seeds and a seed with the cover disperses individually remaining the string. The cover may help stick to animal hairs or clothes and the seeds are scattered by the flood water widely. The root is straight, penetrates deep in the soil, and a nodule of nitrogen-fixing bacterium is not found. The long root regenerates the plant easily though the top is cut off. It stands well in the flood water.

People perceive the plant as a nuisance and they use it sometimes only for a firewood, though it is of low quality. The thorns are thought to be obstacles for fish laying eggs in the bush. The flood is a carrier of the seeds. The plant is not poisonous to human beings nor to fish. It is very difficult to

eradicate the species totally in the flooded area. But it is well controlled manually where farmers grow crops. Though it is laborious to fight against the species, no other ways were found than clearing it elaborately by hands and fire at the places where farmers want to use.

E.1.3 Agricultural Supporting System

(1) Agricultural Research Activity

Agricultural research activity is conducted by 18 national institutions managed by the Department of Agronomy, MAFF. Fourteen institutions operate research activities on rice as their main subject crop. Former Samrong Thom Research Station for tobacco was sold to a private company (see Table E.1.26, E.1.27 and Figure E.1.15, E.1.16, E.1.17).

Basically, six research stations have a main role to operate research activities but most of them train both staff and farmer and some of them produce seeds to support state farm activity. The main activity of five agricultural development centers is extension and training service for both staff and farmer. They also demonstrate new technology on farm/station and distribute agricultural materials to farmers. Three rural development centers have similar roles of agricultural development centers but they provide a more wide range of service, such as credit, raising animals, etc. Four state farms primarily work for seed production.

Generally, the activities of those research institutions are not active due to lack of able staff and enough budget at present. Some institutions receive assistance from foreign NGOs and seems to operate their works more actively than others, but there are only three of them.

CIAP (Cambodia - IRRI - Australia - Project) conducts a lot of researches for paddy. CIAP which former name was IRRI-Cambodia Project started its activities in 1987. The main objective for the project is to increase rice production by improving the stability and productivity of rice based cropping systems. To achieve it, various activities such as research, institution development and project management are now on-going and the components of their researches are as follows;

1. Rice Varietal Improvement
2. Integrated Nutrient Management
3. Rice Ecosystem Analysis
4. Integrated Pest Management

The fruits of researches are officially announced as "Technology Recommendations". Based on the "Technology Recommendations" published by CIAP in August 1995, they approved the release of 12 CIAP sponsored rice varieties for four ecosystems from 1990 to 1993. Four varieties (IR66, IR72, Kru and IR Kesar) for lowland, three (Santepheap1, Santepheap2 and Santepheap3) for upland, three (Don, Tewada and Khao Tah Petch) for deepwater and two (Sita, Rimke) for upland. Among them, preliminary farm interviewing survey shows that IR66, which is suitable for rainfed and irrigated lowland for early duration variety (photoperiod insensitive and mature in 120 days or less), is widely cultivated here and there.

In terms of soil nutrient management, it recommends for soil productivity improvement to use plant and animal waste and green manuring and to incorporate legumes into the cropping rotation where possible. And it also recommends the usage of inorganic fertilizer according to the soil classes. For pest control, it aims biological control for the core of rice IPM (Integrated Pest Management). And for that purpose, it recommends that farmer field schools continue, because based on the farm survey, farmers have a poor understanding of the role of natural enemies.

(2) Extension Service

Agricultural extension service is officially managed by the Department of Technique, Economy and Extension, MAFF. Field service is practically operated by the provincial staff of the Economy, Extension and Techniques Office of provincial agricultural office. Generally, agricultural extension workers are trained in Prek Leap Agricultural College and Royal University of Agriculture (former Cham Car Daung Agricultural Institute) (see Table E.1.28 and Figure E.1.18, E.1.19).

From May, 1996, Australian government starts the official assistance for agricultural extension service, named "Cambodia Australia Agricultural Extension Project (CAAEP)". Four main components of the project are as follows:

- Establish an operational national agricultural extension system
- Strengthen agricultural education
- Enhance village capability to improve agricultural productivity, food security and income through the extension system
- Establish a monitoring and evaluation system to enable proper project reporting

To achieve the target, the project will also strengthen the capacity of the Technical Department and train 484 agricultural extension workers who will be working in 968 communes in 21 provinces. The project is expected to complete its objectives by November 2000 (see Table E.1.29).

(3) Agricultural Material Supply

Cambodian government distributes some of agricultural materials to farmers through local government. Based on the data obtained from provincial agricultural material offices, government deals with some kinds of fertilizer, insecticide, sprayer, rice seed, pump and so forth. The system for distribution is as follows;

1. Provincial office offers projection figure to each district office.
2. Each district office revises it.
3. Provincial office collects figure from each district and adjusts them all together.
4. Provincial office demands the headquarters of agricultural material in Phnom Penh.
5. Headquarters send agricultural material from Phnom Penh to each province.
6. Provincial office sends them to each district.
7. District office distributes them to farmers.

The prices of various materials are fixed by headquarters. In June 1995, the prices are as follows;

◆ Urea	30,000	Riels / Sack (50kg)
◆ 16-20-0	33,000	Riels / Sack (50kg)
◆ 18-46-0	35,000	Riels / Sack (50kg)
◆ 15-15-15	40,500	Riels / Sack (50kg)
◆ Diazinon	9,000	Riels / liter
◆ Sumithion	9,000	Riels / liter
◆ Sunicidrin	98,000	Riels / liter
◆ Hand sprayer	110,000	Riels / set
◆ Pump	2,130,000	Riels / set

According to a provincial agricultural material office, farmer could buy governmental fertilizer by credit before but from this year credit system is abolished and only cash money is available to buy them. During field survey, 25 farmers were interviewed and none of them bought fertilizer from government and they usually bought agricultural materials from local or Phnom Penh market. The distribution plans to each district of the concerned three provinces, except for Kratie and Prey Veng, are shown in Table E.1.30. These tables show that the amount of materials are relatively few. And even in a remote small market, there are actually some amount of fertilizer and insecticide made in Thailand and Viet Nam. Most of the circulation of agricultural materials are nowadays controlled by private commercial sector, but the government should not abolish credit system for the poor, because the credit system may be the only way to get agricultural materials for the poor farmers.

(4) Agricultural Processing

In the five (5) provinces, there are some medium to large scale agricultural processing factories which mainly exist in and around Phnom Penh. However some of them are not in operation. Following are the major processing factories in Phnom Penh related to the agricultural sector:

Agricultural tool factory	1 place(s)
Fertilizer(phosphate) factory	2
Milk factory	1
Winery	1
Cigarette	6
Bran oil factory	1 (not working)
Leather factory	1

In the rural areas, at present, ricemills are the major agricultural processing activities, which are distributed nearly in each village. However, these are used for milling rice for family consumption use, not for commercial utilization, by collecting milling fee of 35 Riels per kg of paddy. In case, customers do not need rice bran, which is by-product of paddy, milling fee is not charged. Milling rate is estimated at 63 % on an average.

For example, in Kampong Cham and Prey Veng districts for which number of ricemills was available, there are 3,112 ricemills which corresponds to about 2 places per village.

Other than those small scale ricemills in the rural areas, there are some medium scale ricemills managed by private owner, most of them are also a wholesaler, located along national roads. Purchasing price of paddy from trader and farmers at ricemills ranges between 300 Riels/kg and 500 Riels/kg. Ex-mill price of white rice is from 500 and 900 Riels/kg depending on its quality. Milling condition is the same as that of the small scale one so that milling fee become free of charge when customers do not need rice bran. Price of rice bran at ricemills costs at 200 Riels /kg, however, owner of ricemills sells rice bran to a market as animal feed at about 250 Riels/kg.

Because of unsuitable storage condition at ricemills, it is reported that about 2 % of paddy/rice are lost during storing procedure.

(5) Marketing of the Products

The Rural Socio-Economic Survey shows that the rate of farm households not selling paddy to market was generally higher implying that paddy production in the Study Area is mainly for home consumption use. The balance of paddy in each district can not always meet district demand. Among five (5) provinces, only two (2) provinces, Prey Veng and Take, met the district paddy demand.

The main agricultural product on marketing channel is paddy which occupies about 90 % of planted area of Cambodia as a principal food of the Cambodian people. However, no formal organizational marketing activities are observed. At present there are two (2) channels for paddy marketing as shown below:

Farmers → Ricemill → Wholesalers → Consumers
Farmers → Traders → Ricemill → Wholesalers → Consumers

Farmgate price of paddy differs from 250 to 300 Riels/kg. Milled rice/white rice is sold at 800 to 1,400 Riels/kg depending on its quality. The major problem on marketing paddy are low price of paddy and instability of price.

Vegetables and maize are marketed mostly on the same channel as shown below:

Farmers → Middlemen → Consumers
Farmers → Market → Consumers

In harvesting season, middlemen go to farmlands to purchase products and transport them to market by truck. When farmer goes to market to sell farm products by themselves, own or hired motorcycle are used. Hired rate of motorcycle is 4 Riels/kg/km. Averaged farmgate prices of maize is estimated at 230 to 300 Riels/kg, and 400 to 500 Riels/kg for leafy vegetables. Vegetable prices fluctuate seasonally depending on its production from 300 to 2,000 Riels/kg.

Fattened pigs with a body weight of about 70 kg are marketed through trader's motorcycles and trucks.

COCMA(Central Company of Agricultural Materials) is responsible for distribution of fertilizers, which are donated through KR II etc., to farmers through a provincial agricultural offices at the government prices. Other than COCMA, farmers can get fertilizer and agricultural chemicals from a private dealers at higher prices than government one.

(6) Agricultural Credit

At present institutional credit is not available in Cambodia. Despite of 31 commercial banks in Phnom Penh, none of them offers rural credit for smallholders and rural households. Various informal credits are available in the rural areas enforcing farms to repay at higher interest rates. In the First Socio-Economic Development Plan (1996 - 2000), the need for rural credit and poverty alleviation are emphasized. Some 30 % of the farmers in the Study Area is in debt borrowing money from relatives, neighbors, money lenders and so on.

To prevent farmer's disadvantage in crediting, many NGOs such as GRET, ACLEDA, PRASAC, World Relief, etc. support rural people by providing agricultural credits.

GRET(Group De Recherche Et d' Echanges Technologiques Project Credit Rural), French NGO, starts its activities in 1991, covering three (3) provinces of Kandal, Prey Veng and Kampong Speu. It is estimated that about 70 % of the total amount of lended money is used for agricultural use and 30 % for livelihood. The interest rate applied for GRET credit 4% per month with maximum amount of 150,000 Riels(60 US\$) in cash. Due to good solidarity among farms/members, ratio of repayment at present is reported 100% in the three(3) provinces. Before starting lending in the villages, GRET investigates farmer's solidarity by holding assembly for the explanation of GRET lending system. Those GRET activities have subsequently been linked to the Ministry of Agriculture, Forest and Fisheries through the rural credit Bureau of the Department of Agricultural Extension.

Rice Banks are managed under the rural development centers, which are supervised by the Department of Agronomy. There are two centers in Kandal province and one in Kampong Speu. The purpose of this bank is to alleviate farmer's debt by lending paddy and money particularly for poor farmers. Applied interest rate are 2.0 % per month for paddy and 3 % per month for money, respectively. For example, there exists 65 Rice Banks in Kandal Stung district in Kandal Province. Some 65 farmer clubs are organized to manage this system in collecting responsibility of farmer/members.

E.2 DEVELOPMENT CONSTRAINTS AND POTENTIALS

E.2.1 Soil

Based on the data obtained from the CIAP (Cambodia - IRRI - Australia - Project), paddy soils are agro-ecologically classified into seven soil classes. The three major classes dominantly covering the Study Area are as follows;

Class 13

This soil class corresponds to Alluvials and Lacustrine Alluvials. This soil is distinguished by a well structured, friable, dark gray to black, sandy clay loam to clay surface soil which develops large cracks when dry. These soils are formed on recent alluvial deposited during annual flooding by river waters and, in some cases near the edge of the flood plain, colluvial material washed down from surrounding higher lands. The class is defined because of the well maintained fertility and structure of the soil as well as the potential for good water supplies which has implications for fertilizer management, tillage, water management and cropping rotations. Unfertilized yields of this soil average between 1.5 to 2.0 ton/ha and under rainfed conditions, 2.5 to 3.0 ton/ha with good water control.

Class 5

This soil class corresponds to Cultural Hydromorphics and Grey Hydromorphics. This soil is distinguished by a shallow, poor to moderately fertile, fine textured, A horizon. Soils in this class are developed on old alluvial terraces but receive water, minerals and erosion materials in runoff from the surrounding upper and middle paddies. The class is defined because of its fine textured, shallow surface soil, the presence of the plow-pan restricting root growth and water penetration and the hydrology of the soil receiving water runoff from surrounding lands. These properties have implications for fertilizer management. Unfertilized yields of this soil average between 1.0 to 1.5 ton/ha.

Class 14

This soil class corresponds to Brown Alluvials. This soil is distinguished by a well structured, friable, brown, reddish brown to grayish brown surface soil with very little profile development. This class occurs primarily on land adjacent to the Mekong, Bassac and Tonle Sap rivers. The soil has developed on recent alluvium and comprises the natural levees and back slopes. The class is defined because of the high fertility of the soil and good structure and good drainage and water supply which has implications for tillage and cropping rotations. Unfertilized yields of this soil average between 1.5 to 2.0 ton/ha and under rainfed conditions, 2.5 to 3.0 ton/ha with good water control.

Chemical analysis of 14 soil samples does not indicate that there is a significant difference between the two soil groups; along the Mekong and away from the Mekong. Quantitative differences could not be improved, but according to the interviewing, the farmers living along the Mekong, Bassac and Tonle Sap rivers generally know that flooding water and sediments brings better harvest from their experiences.

Usually, silt has little electrical function to absorb nutritious cation/anion. Primarily, silt conveyed by flooding water has a role to enlarge farmland with leveling up the lowland height and it may have some positive effect such as soil dressing. And also annual flooding period brings reductive soil situation and some disinfecting effect against pathogenic aerobic micro-organism and fungus in soils.

Potentials

- With good farm management, high yields are expected on recent alluvial soils.
- Although not improved quantitatively, annual flooding water gives positive effect on soils such as enriching nutrition. It enables low cost agriculture.
- Annual flooding water from rivers gradually enlarge farmland by leveling up height.

Constraints

- Without fertilizer management, soils in lowland are generally infertile.

E.2.2 Agriculture

(1) Farmers

The average number of farm labor per family is 4.25 persons composed of 2.05 men and 2.20 women. There is not a difference among farmer types of practicing paddy season but it seems that the differences among provincial averages are large, namely the average of Prey Veng is larger than those of other four provinces. Kamchay Mear, Prey Veng has the largest figure, 6.09 persons (see Annex "Summary Results for Agriculture Section of Rural Socio-Economic Survey").

It is said that the Cambodian agriculture is generally extensive but the farmers in the Study Area are seemed to use fertilizer commonly. Those who use fertilizer represent 82 % of all and every farmer of all types in Takeo uses it. Urea and 16-20-0 are common fertilizers. Applying agricultural chemicals, particularly insecticide, is also familiar among dry paddy practicing farmers in all provinces. Methyl-parathion and Monocrotophos are widely used in the Study Area. Among all agricultural chemicals, six kinds are classified into extremely/highly hazardous by WHO. According to the Department of Agronomy, the use of those extremely/highly hazardous chemicals will be banned in the future.

Generally, farmers in the Study Area regard lack of irrigation water and pests as the serious problems on farming. Except for none-paddy farmers, this tendency is consistent. Drainage and diseases are the second largest groups. Lack of agricultural material counts on only 10 % (see Annex). From those facts and field survey, following potentials and constraints are derived;

Potentials

- Generally, lack of agricultural material is regarded as one of the causes of low productivity in Cambodia, but applying fertilizer and agricultural chemicals are common among farmers in the Study Area .
- Applying fertilizer and agricultural chemicals become popular among farmers, it means that if proper application is widely extended, production will increase.

Constraints

- Applying fertilizer and agricultural chemicals becomes popular among farmers, still those materials are expensive.
- Some of the agricultural chemicals are extremely hazardous. If application method and dosage is not proper, not only the harvest will decrease but also some environmental or health damage will occur.
- Lack of irrigation water and diseases are the most serious problems on farming.

(2) Farmland Holding

The results of the Rural Socio-Economic Survey show that 97 % of farmers (872 / 900) have land title for their farm land and the area average is 1.19 ha. The farmers who do not have land title count 25, which is only 3 % (see Annex). There are following potentials and constraints.

Potentials

- Almost all farmers have their own farm land and there is no problems about agrarian reform or landlords/tenants disputes which sometimes occur in the developing countries, such as the Philippines.

Constraints

- If a farmer has only wet season paddy field, the shortage of home consumption rice may occur. - Average number of household is 6.59 persons and an average family consumes more than 1.6 tons of paddy annually. (annual rice consumption per capita - 152 kg, conversion factor to milled rice - 62 %, $6.59 \times 0.152 / 0.62 = 1.62$ tons) Even if the average farm land, 1.19 ha, is all cultivated to wet season paddy, they can not sustain their own rice because the average yield of wet season paddy is only 1.48 ton/ha. (for seed and post harvest loss - 15 % of harvest paddy, $1.48 \times 0.85 \times 1.19 = 1.50$ ton)

(3) Farming Practices of Paddy

Paddy practicing farmers are classified into three categories by cropping season; only wet season paddy practicing farmer, only dry season paddy practicing farmer and both wet and dry season paddy practicing farmer. According to the Rural Socio-Economic Surve, wet season paddy practicing farmer occupies 27 %, dry season paddy practicing farmer occupies 37 % and both wet and dry season paddy practicing farmer occupies 34 %.

Among the interviewed 900 farmers, there are only two farmers who cultivate floating rice in the Study Area, one in Koh Thom, Kandal, and the other in Prey Kabass, Takeo. This figure is lower than the expectation and it suggests that the area for floating rice cultivation decreases rapidly in the Study Area in recent years.

At present, whole farming practices exclusively rely on manual labor and draught animals. Each farm household has about 4 farming labors and 2 draught animals on the average. From the viewpoint of labor intensity, both figures seem to be enough for the average holding farmland, 1.19 ha. But calves are probably included in the number of draught animals and number of animals per one hectare of paddy field is insufficient. Due to poor agricultural infra-structure conditions, the area is very few, where agricultural machines such as 4-wheel tractors can be used. Mobile pump is

one of the proper tools to improve present agriculture because it is small, cheaper than other big machines, useful for both in wet and dry season and easy to transport. From those facts and the results of field survey, following potentials and constraints are derived;

Potentials

- More than half of farmers are self sustaining farmers, it means that market price does not largely effect them.
- There is a wide range of paddy varieties - a wide range of environmental adaptability; some with higher drought resistance, others with better tolerance of submission time.

Constraints

- There is a wide range of paddy varieties - many unidentified local varieties. This is one of reasons of low productivity.
- In wet season, it is difficult to control annual flood from the Mekong.
- In dry season, it is impossible to grow paddy without irrigation water.
- Farmers usually keep rice seed by themselves and it may induce variety deterioration.

(4) Farming Practices of Other Crops

At present, upland crops and fruits represent only small part of whole agricultural production. In spite of small amount of production and poor infrastructure for transporting, the demand of those items are not in serious shortage. Phnom Penh has almost one million population but its suburbs become vegetable supplying areas for capital demand. Several districts, such as Kean Svay, Saang, Muk Kampoul, have some extent of upland fields on river banks, and various cash crops are cultivated there both in dry and wet season. There are following potentials and constraints.

Potentials

- Upland crops consume less water than paddy, so it is possible to cultivate for farmers who can secure few irrigation water.
- In the long term, the consumption of vegetable will increase in accordance with economic development.
- There are some possible export crops, such as maize, mungbean, soybean, etc.

Constraints

- At present, the condition of storing facility is poor, so it is impossible to make marketing adjustment.
- Food consumption is concentrated on rice due to eating habits and the domestic demand for upland crops is not yet large enough.
- In wet season, it is limited for planting areas because of flood.
- The quality of product is generally low because of not-improved varieties, low farming techniques, etc.

(5) Women in Agricultural Activities

So far, it is said that women labor has a great role in Cambodia resulting from long civil war. From the Rural Socio-Economic Survey, average women labor in agriculture is yet larger than that of men labor but the difference is quite small. And half of working hours per day of woman are still

dedicated to farming practices. This fact implies that woman enrollment in agricultural development and extension in future is very important and indispensable (see Annex).

Potentials

- On the average, women labor in agriculture is still larger than men labor. Women participation is one of the keys for rural and agricultural development.

Constraints

- Because women have a lot of roles besides farm practicing, it is difficult to set them in the center of development plan.

(6) Relationships between Paddy Production and Hydro-Meteorological Data

Paddy production of the five provinces concerned and two hydro-meteorological data were roughly analyzed by correlation analysis to check whether there is a specific relationship between them because it is said that the paddy production in Cambodia is highly influenced by natural conditions, particularly rainfall during wet season. The analyzed relationships are as followings;

- 1) Relationship between paddy production and high water level in Chaktomuk
- 2) Relationship between paddy production and annual rainfall
- 3) Relationship between paddy production and rainfall in July and August
- 4) Relationship between paddy production and rainfall in September and October

Among four of them, 1) and 2) are examined whether there is a general correlation between paddy production and high water level/annual rainfall. Other two, 3) and 4) are examined whether the rainfall for some specific periods influences paddy production or not.

It is expected that there may be some relationships between paddy production and two hydro-meteorological data because rainfed paddy cultivation is still major in the Study Area and annual flood sometimes give serious damages to paddy production. However, the results of analyses show that there are not strong relationships among them. Only three relationships in Prey Veng and Kandal are significantly correlative between paddy production and hydro-meteorological data. If the data are analyzed more precisely, some specific relationships may be observed, or it suggests that paddy production in each province may be much more influenced by other factors (see Table E.2.1, E.2.2 and Figure E.2.1).

E.2.3 Agricultural Supporting System

(1) Agricultural Research and Extension Service

As mentioned in the previous section, agricultural research and extension service are officially managed by two different departments of MAFF. Research activities which is managed by the Department of Agronomy (DOA) are primarily divided into two phases. It is the first phase to research various agricultural constraints in Cambodia. This phase includes varietal improvement, development of new technologies. Those researches are mainly conducted by six research stations. The next phase, the seeds multiplication of improved varieties are operated by four state farms and then the seeds are distributed to farmers. The main activity of five agricultural development centers and three rural development centers is extension and training service for both staff and farmers.

The organizational framework of the Department of Technique, Economy and Extension (DTEE) is just established this year and it started to work lately. Up to November 2000, the Australian government will continue to assist the national agricultural extension system (CAAEP). Because the project has just started, there is no appearance of result.

Although DTEE has newly established this year, some function of extension is still under DOA management. And it will take some more time to get results of CAAEP.

Potentials

- The long term project for agricultural extension service assisted by the Australian government has just started. The fruits of the project will bring effect in commune level.

Constraints

- Agricultural research institutes are concentrated around Phnom Penh.
- Agricultural extension service is officially managed by DTEE. But the actual extension service on the field is operated by the two different departments, DTEE and DOA. This may cause some problems such as sectionalism.
- Most ongoing research activities set on paddy as objective crop and research for upland and tree crops is conducted just on a small scale.

(2) Processing and Marketing

Ricemills are the prevailing agricultural processing in the Study Area excluding medium and large scale processing factory in Phnom Penh. At present, commercial basis agro-processing might be difficult because present agriculture is basically for the purpose of meeting self-sufficiency of food of the country.

However, it will be possible for some crops planted in the Study Area to be processed into value-added products as shown below:

- Rice bran----- extraction of oil
- Maize----- animal feed
- Mungbean ----- noodles
- Sesame ----- extraction of oil
- Soybean----- extraction of oil
- Cassava ----- animal feed
- Groundnut ----- extraction of oil
- Sweet potato ----- alcohol
- Vegetables----- dried vegetables(onion, garlic etc.)
- Soybean cake----- animal feed

Potentiality for agro-processing should be studied, however, small-scale processing would be recommended in considering supply of raw materials and financial difficulty of farmer's. In parallel with the study on processing, institutional credit services at low interest should be implemented to promote small scale rural industries.

Marketing of agricultural products has been done by individual farmers because of lack of agricultural cooperatives. For more profitable marketing, establishment of agricultural cooperatives should be studied so as to enlighten farmers on institutional marketing activities.

Farm roads in the Study Area are very scarce causing difficulty in transportation of agricultural products and inputs. Construction of farm roads will also contribute to improvement of traffic and communication in the rural areas.

(3) Agricultural Credit

About 90% of the farm households is considered as poor family in Cambodia and this is also confirmed with the Rural Socio-Economic Survey conducted by the Study Team. Farmers in the Study Area have small farmland and paddy production is absolutely depending on unstable rainfed farming and their financial status is usually very weak.

Agricultural credit is, therefore, necessary to substitute rice deficit of poor farmers as well as to facilitate and improve agricultural production. At present, rural credit services in Cambodia is going on under the cooperation of foreign NGOs because of lack of institutional agricultural credits. It is reported that farmers lending credit from those NGOs have accepted and understood the crediting system and repaid interest on time at higher rate. It is forecasted that demand for rural credit will increase year by year with the economic growth of Cambodia.

E.3 BASIC DEVELOPMENT PLAN

E.3.1 Colmatage Farming Improvement Plan

(1) Agricultural Land Use

1) Basic Concept

At present, colmatage farming is one of the most productive farming system not only in the Study Area, but also in the whole of Cambodia. It is also adapted for the natural conditions and utilizes them for agricultural production.

Upland and recession rice fields, characterized colmatage farming, is usually formulated along each colmatage canal and fertilized every year from nutritional sediments of annual flood. Basically, upland field is composed of fertile soil such as brown alluvial or alluvial soil. The expansion rate of upland field depends on the conditions of each colmatage canal, flood extent, the contents of flood water and so forth, so it is difficult to estimate or forecast its average. The farming itself has continued since the end of the last century because of its sustainability and environmental adaptability.

In consideration of those characteristics, it is the basic concept not to change the present system and land use pattern but to maintain the present colmatage farming system and promote the development of the system under proper management.

2) Agricultural Land Use

Upland field developed along the colmatage canal is classified into two types, namely the non-flooded upland field and the flooded upland field. The non-flooded upland field is usually distributed along the river banks and the canals. Anytime in wet season, farmers can practice farming with rainfall on the field. During dry season, farming is impossible without irrigation water but some farmers recently practice dry farming utilizing water remained in colmatage canal and they sometimes use small mobile pumps for irrigation (see Figure E.3.1 and E.3.2).

Next to the non-flooded upland field, lie the upland field, receiving periodic flood through colmatage canal. Generally, this upland field is cultivated before/after flooding so cropping season depends on the flood water level and is not uniform every year. In the very long term, this upland field will be gradually built up and change to non-flooded upland field by sedimentation of annual flood.

By the rehabilitation of colmatage system, it is possible to keep flood water in the colmatage canal for irrigation during dry season by operating water control facilities such as gate and it makes possible to practice dry season farming. Consequently, it is the target for the colmatage farming areas to make the possible cropping season longer by utilizing water stored in the colmatage canal and expand agricultural production through cropping intensity increase without any changes in land use.

(2) Farming Practice

1) General

Basically, colmatage farming is defined as farming on the upland fields extended along the canals and rivers. It includes only small area of dry/wet paddy farming practiced around back swamp areas at the end of colmatage canal.

Colmatage farming system is one of the most diversified agriculture in Cambodia so it is well adapted to a national agricultural policy; crop diversification. It is also market-oriented agriculture, especially in the three districts in Kandal, Saang, Kean Svay and Muk Kampoul located around the capital, Phnom Penh.

On the non-flooded upland fields, farmers plant a wide range of crops such as maize, sesame, sugarcane, mungbean, vegetables, etc. On the river banks, where they have the least possibility to receive flood and are residential areas, the mixed cultivation of home consuming crops and fruit trees such as banana, mango, longan and so forth is usually practiced.

On the upland fields where it receive annual flood, short duration crops such as maize, mungbean, sesame, are commonly cultivated before flood; from May to August. After the flood water start to recede, the crops which can survive with less water from residual soil moisture like some vegetables, peanut, tobacco, are cultivated in addition to those above mentioned crops.

2) Farming Plan

Since the colmatage farming is highly diversified and considered as one of the most productive farming in Cambodia, basic farming system will not be changed. The agricultural production increase in the areas will be achieved through the increase in cropping intensity during both dry and wet season.

As mentioned above, the colmatage farming of the three capital suburban districts functions as vegetables supplying areas and this farming is the prototype of typical agriculture of suburbs observed in other countries. For these areas, the target of development is to expand the present farming and make it more intensive through market incentives. In particular, leafy vegetables, easy to get damage in handling and transport, are important for those suburban areas.

For other colmatage farming areas, remote from the capital/populated areas, the large-scale vegetable production is not practical because of some problems such as marketing and transport. For those remote areas, the stable production of cereal and legume crops is recommendable as a first target under the poor infrastructure conditions. Those two crops can be stored for a longer duration after drying and are possible to export in the future. Moreover, legume crops can contribute to maintain soil fertility through the action of rhizobium in the soil.

Leuk Dek in Kandal, has 51 colmatage canals along the Mekong, which could be one of the models for these remote areas because its colmatage farming is highly concentrated on maize production during early wet season; before flooding. Koh Thom in Kandal could be another model which is characterized by dry season chili cropping. Dried chili is presently exported to Thailand.

The annual flood water also brings the seeds of the nuisance thorny plant, *Mimosa pigra*, and therefore constant manual land clearing is necessary to be able to use the land which receives flood for either short or long period.

(3) Agricultural Supporting Services Development

1) Agricultural Research and Extension Service

Colmatage farming is characterized by upland crops and recession farming. Practiced crops are many; vegetables, cereals, legumes, industrial crops, fruit trees, etc. Still there is only one research institute in Kean Svay, Kandal, which sets vegetables as main objective crop in Cambodia. It provides three services, (1) selection and multiplication of vegetable seeds, (2) research activity of vegetables, (3) training for both governmental workers and farmers, but its activities are limited due to lack of technical staff and budget. In spite of its limited human resources, there are only eleven staffs in the vegetable research center, it provided two-week farmer training course 14 times in 1995, 25 to 30 farmers a course. Training course was financially supported by NGOs.

To increase agricultural production of upland crops in colmatage farming areas, it is indispensable to strengthen the research activities for all kinds of upland crops. In consideration of the present budgetary and staff constraints, some of the concrete targets should be set as high priority objectives. The following are possible objectives; (1) selection of variety of several major upland crops which are highly suitable for colmatage farming, (2) seed multiplication of the selected variety, (3) establishment of seed distribution system. Moreover, the development of upland crops specialist is also important. In addition to the continuous domestic training in a long term, the invitation of some researchers is recommendable because it has the immediate effect.

Present extension services are officially managed by DTEE, although now practiced by two departments; DOA and DTEE. The number of extension workers of concerned provincial agricultural offices is very few for technology extension. Since Australian official assistance for DTEE has just started this year and will complete and achieve its objectives in 2000, practical results can not be observed. Close exchange of technical information between research and extension departments is vital to effective extension.

In the colmatage farming areas, application of agricultural chemicals, in particular, insecticide for vegetables, is more common and frequent than in other areas. If application method/dosage is not proper, not only the harvest will decrease but also some health/environmental damage will occur. Application standard for agricultural chemicals should be made immediately and extended to the farmers through extension service.

Technological improvements for vegetables no matters how slight are very useful. (Ex. 1: Corn and some leafy vegetables deteriorate earlier when they are kept horizontally than vertically. 2: By preparing separate nursery bed for upland crops made from local materials such as banana peel, it is possible to make short the growing duration on the main field and consequently increase cropping intensity.) Such low cost and instant technologies also should be extended to the farmers.

2) Agro-Processing and Marketing

The areas irrigated by colmatage canals will practice crop diversification planting with maize, mungbeans chili and other upland crops. In particular, Kandal province, can be characterized as upland crop producing areas in the future because of its water availability and good accessibility to Phnom Penh. Phnom Penh is the biggest market in Cambodia, in which about 7 % of the entire population live. Therefore, it could be said that potentiality for agro-processing and marketing is the highest in the Study Area. In considering production of diversified crops and paddy the following agro-processing could be planned, however, small scale industry should be studied if the present condition of this sector is taken into consideration.

Rice bran----- extraction of oil
Maize ----- animal feed
Mungbean ----- noodles
Sesame----- extraction of oil
Cucumber----- pickles
Vegetables----- pickles, dried vegetables(onion, garlic etc.)

3) Agricultural Credit

As mentioned above, the potential for intensive agriculture in these colmatage farming area is high because of availability of irrigation by colmatage canals. However, annual farm household incomes in this area do not meet poverty line of about 2.23 million Riels per family. As farmer's capability for diversified farming and demand for agricultural credit are considered higher than other areas as well, institutional credit available for individual farmers and farmer's group should strongly be implemented to expand and promote intensive agriculture and agro-processing.

E.3.2 Agricultural Development Plan Harmonized with Fisheries

(1) Land Use

1) Present Conditions

In the study area, not only agricultural land but also several other land categories are included. For example, inundated bush is not used for agriculture but it has some important functions for fishes to provide hatchery and habitat. Standing water, lake and reservoir, is utilized for both agriculture as irrigation water resource and fishery as fishing ground and fish habitat. Moreover, many fishing lots are set without any consideration of the relation between agriculture and fishery. The boundaries of fishing lots may clear on the maps, but not clear on the field.

Present land use situation in the study area is not uniform, it changes in accordance with the seasonal shift of water level. In dry season, the water level goes down and some upland crops and two kinds of paddy which includes flood recession paddy and dry season paddy with irrigation are practiced around reservoirs/lakes, where is inundated in wet season. Other land categories, such as inundated bush, waste land and swamp, are not used except for pasture land during dry season.

In early wet season, some legume crops and vegetables are partly cultivated before flooding. The cropping areas decrease and commercial/family fishing are active with the rise of flood water. Although the planted area of deepwater paddy is decreasing in recent years, it is still cultivated in small areas.

2) Land Use Plan

Freshwater fish is one of the important protein sources for Cambodia which is a land locked country, but its overall fish catch is stagnated in recent years due to the reckless fishing and so forth. Accordingly, in the fishing lots, the agricultural land expansion to non-agricultural land such as inundated bush/forest, grassland, waste land, swamp, is not recommendable because it is feared that the decrease of fish habitat induce the further deterioration of freshwater fish capture. Out of the fishing lots, the agricultural land expansion to non-agricultural land is planned just in case that reclamation has no effect on fish resources.

As for fishing lots, the boundaries are not clear and that may induce confusion of land use on the field. It is important to set the boundaries clearly and notify to the concerned people for the coexistence of agriculture and fishery in the future. In that case, setting boundaries should be made not only by the authorities concerned but also by the residents. If the residents are not included, some problems may occur.

Because of annual flood from the Mekong and the Bassac, land use situation will not significantly change in the future. In the relatively high fields which receive late flood, cultivating some upland crops till flooding should be recommended and the expansion of agricultural production will be attained through the increase of cropping intensity. In dry season, the present land use situation will be almost same but some land reclamation to non-agricultural land will be done to expand production (see Figure E.3.3 and E.3.4).

(2) Farming Harmonized with Fisheries

1) General

Cropping patterns in the areas are limited because agricultural activity can be practiced only during non-flooded period. At present, two dry season paddy cropping patterns including flood recession paddy and dry season paddy with irrigation, are main activities and some upland crops are cultivated in early wet season before flooding. (Flood recession paddy is transplanted as the flood water recedes and then irrigated supplemental water using water held in reservoirs built by low dikes and in canals.) Deepwater paddy is also planted in small areas. But its planted areas decreases gradually and convert to dry season paddy cropping because it is necessary to adapt a wide range of environmental change like flood duration and flood water depth varying every year and the unit yield is low and unstable. Waste land and grassland are used for pasture land during dry season.

Though there is no statistical data which describe planted areas/production for this plan area, the two types of dry season paddy have generally higher unit yield and more productive than the wet season paddy.

2) Farming Plan

For the areas where irrigation water is secured in dry season due to the development of water control facilities, it is possible to expand dry season paddy and upland crops farming after receding flood water till the commencement of rain in wet season. Receding time is influenced by elevation, geography of the area, flood extent, and it is variable every year.

Dry season paddy with irrigation needs irrigation water throughout the growth period so its large-scale introduction to the plan is not practical because large water control facilities are also necessary to secure enough water. Flood recession paddy, utilizing flood water for the early stage of growth, needs less water than dry season paddy with irrigation so it could be cultivated on larger areas in comparison with dry season paddy with irrigation, using the same volume of water resource. If the projected facilities are not enough for the water requirement of flood recession paddy or the expansion of upland crops farming has higher priority than flood recession cropping, the expansion of agricultural production will be attained through the introduction of upland crops. The main objective of the plan is the expansion of flood recession paddy and upland crops farming by the proposed water control facilities.

As for flood recession paddy, the yield is generally higher than that of wet season paddy, represented 80-90 percents of both planted area and production in Cambodia. Moreover, there is the possibility of buying fertilizers at cheaper prices (because of lower demand) and of selling rice at higher prices than during wet season. On the other hand, the supplemental irrigation is necessary during growth period so if gravity irrigation is impossible in the areas, pumping irrigation is required. Based on the Rural Socio-Economic Survey, conducted by the JICA Study Team, there are only four percents of paddy with practicing farmers who have mobile pumps for irrigation. (36/855-of the 36, 35 farmers are dry season paddy practicing farmers.) The majority of farmers, who have no pumps, sometimes have to rent pumps. Accordingly, the expansion of flood recession paddy needs the extension of mobile pumps and it is one possible option to establish a public bank of mobile pumps or the cooperative ownership of one mobile pump by several farmers.

(3) Agricultural Supporting Services Development

1) Agricultural Research and Extension Service

In Cambodia, there are presently 18 agricultural institutes, such as research station, agricultural development center, rural development center and state farm, under the management of DOA. Paddy is set as the main objective crop for research activity of 12 institutes. Among them, there are six institutes in Kandal and one institute in Takeo.

For the agricultural development plan harmonized with fisheries, it is one of the main targets to expand dry season paddy cropping. Based on the Rural Socio-Economic Survey, 77 % of dry season paddy practicing farmer (480/623) adopt three of IR varieties, IR66, IR36, IR42, and 83 % of them (517/623) adopt the improved IR varieties if other IR varieties are included. In general, the average yield of IR varieties is higher than that of the native varieties but IR varieties need more careful management such as fertilizer application and water control. It is

consequently necessary to make the proper cropping standard for dry season paddy and to extend it to farmers.

The Rural Socio-Economic Survey shows that 94 % of paddy practicing farmer (784/835) habitually use self-keeping rice seed and 89 % of the dry season paddy practicing farmers (286/320) who adopt even IR varieties use self-keeping rice seed. These facts may induce the production decrease due to the variety deterioration. Variety deterioration in the tropics usually progresses faster than in the temperate regions so it is recommendable to renew rice seed every several years. But the present rice seed multiplication and distribution system is not enough to satisfy domestic demand and the strengthening of the system will be needed.

For seed multiplication, more state farms should be established to strengthen the present weak system. In a long term, it is ideal to set one seed multiplication farm in each province because every province has its local varieties adapted to its local environment. The seed multiplication works presently conducted by several research institutes should be transferred to state farm entirely. This transference enables to clarify the functional difference between state farm and research institute.

If the increased earnings derived from the use of certified seed is more than the purchase cost, the use of certified seed is profitable and will be extended. It is recommendable to set model farms to compare the differences of both seeds and inform them to farmers.

Cambodia-IRRI-Australia Project (CIAP) has continued paddy research activity including field test and training/seminar with DOA since 1987 and has accumulated a lot of useful results and knowledge. Based on those activities, technology recommendations are suggested every year. Since the Australian government also gives official assistance to strengthen agricultural extension system with DTEE (Cambodia Australia Agricultural Extension Project, CAAEP), close cooperative activities of CIAP and CAAEP, paddy cropping support system in combination of research and extension, will bring more fruitful results.

2) Agro-Processing and Marketing

This area is mainly located along Mekong and Bassac rivers covering Kampong Cham, Kandal, Prey Veng and Takeo provinces. Fishing lots are distributed along the rivers particularly in the downstream of the Mekong and Bassac rivers. Agricultural potential aiming at intensive farming could be considered as the same as the colmatage areas. However, potentiality for fishery processing should be considered in addition to agriculture.

Fish -----dried fish, smoked fish, fish meal, fish sauce
Rice bran -----oil extraction
Maize -----animal feed
Mungbean -----noodles
Vegetables -----pickles, dried vegetables

In Cambodia, fish is an important animal protein source taking about 15 kg per capita per year. This imply higher demand for processed fishes in the future too. Taking into account increasing demand for fishes, fish processing would be recommendable and can be realized easier than agro-processing as small-scale fish processing is already practiced in the area. Agricultural

processing mentioned above could also be planned in small-scale aiming at consumption in and around Phnom Penh.

3) Agricultural Credit

As the commercial fishing is active in this area, demand for credit for fishing and fish processing might be higher than agricultural sector, and the potential for fish processing is considered high as mentioned above. However, rural credit services in Cambodia is going on only under the cooperation of foreign NGOs due to lack of institutional agricultural credits. The institutional credit for agriculture and fishery sectors should be implemented and applied at low rate for both farmers and fishermen to encourage these sectors to increase production.

E.3.3 Rainfed Agricultural Development Plan

(1) Land Use Plan

1) Present Conditions

In the area for the rainfed agriculture development plan, main land use is wet season paddy, commonly submerged less than 0.5 m depth. Some forest land, bush, inundated bush and waste land, such as swamp, grassland, are partly distributed, too. Forest areas including bush and inundated bush have important functions in the supply of firewood, as the only energy and material source for rural people. Other land items, waste land, grassland, etc., are not used except for pasture land before and after flooding.

Many palmyra palms (*Borassus flabellifer L.*), which characterized Cambodian rural scenery, are planted on the paddy levee in the rainfed agriculture area. Rural people not only eat their fruits and endosperm, but also tap and make sugar, use their leaves and woods for roof/wall/fence and housing material. Due to the many uses, they are indispensable for the lives of rural people. Making sugar looks like a good agro-processing business but it needs about 20 years after planting before they can be tapped for sugar and a lot of firewood and processing equipment is needed so there are not so many farmers practicing it.

2) Land Use Plan

Irrigation water will be secured by the development of water control facilities but the amount is limited in consideration of the present hydro-meteorological and natural conditions in the area. Accordingly, the present rainfed paddy area, occupying most of the concerned area, will not change in terms of its utilization pattern.

Forest land area still has important roles for rural people through supplying of energy and various living materials so it should not be the objective area for the farmland reclamation, but instead should be preserved and developed. The farmland reclamation to non-utilized land such as swamp, grassland and waste land is not prohibited but lowland should be firstly examined the possibility to be developed the small-scale water control facilities. In Kampong Cham and Kratie, where the average titled land per farm is relatively small, the demand of farmland reclamation to forest areas may be higher than other provinces but it should be avoided as much as possible due to the above mentioned reasons.

(2) Agricultural Development Plan

1) General

In the area concerned, wet season rainfed paddy is predominantly practiced. Rainfed paddy is generally defined as surrounded by levee and submerged for some period during growth period, not deeper than 0.5 m for more than 10 continuous days. There are usually no water control facilities on these rainfed paddy fields and the farmers can not control water level of the fields adjusting the growth stage and the climate condition. This means that it has much possibility to receive drought/flooding damage. Consequently, the farmers adopt the cropping patterns taking possible risks and various conditions into consideration and practice farming without using expensive input material but with self-keeping rice seed which are photo sensitive and of native varieties.

In general, the wet season rainfed paddy field is classified into five field types but their distribution in the area is not clarified. The five field types are as follows;

- (a) Paddy field with good conditions
- (b) Paddy field with frequent drought damage
- (c) Paddy field with frequent flooding damage
- (d) Paddy field with both frequent drought and flooding damage
- (e) Paddy field with medium submergence

For type (a), the technology of dry season paddy cropping could be applied to some extent but for other four types, each needs the proper variety and technology.

Based on the Rural Socio-Economic Survey, the upland crops introduction ratio of wet season paddy practicing farmer remains at low level, only 36 % (83/232). In Kampong Cham, where paddy production may not be enough even for self-consumption judged from the average titled farmland, about half of wet season paddy practicing farmer (46 %) introduces upland crops.

2) Farming Plan

In the area, it is difficult to secure the large-scale water resource for large area, but the consecutive development of the small-scale water control facilities gradually increase the area of paddy field possible to control water level (see Figure E.3.5).

At present, farmers usually transplant seedlings in July/August, because rainfall is not reliable in the beginning of wet season and this may induce the flooding damage in September/October by high water level when the flood is bigger than the average. If some amount of water resource can be secured in May/June, some farmers can hasten the transplanting time and paddy production will be more stable. To hasten the transplanting time, it is also necessary to replace planted varieties from the predominant medium/late photoperiod sensitive native ones to the early photoperiod insensitive native or improved ones. Changing the varieties should be simultaneously programmed with the facility development. (Rainfed paddy is usually composed of the three native variety types; Early type : mature in less than 120 days, photoperiod insensitive-flowering before mid-October, Medium type : mature in 120 - 150 days, photoperiod sensitive-flowering between mid-October and mid-November or photoperiod insensitive, Late

type : mature after 150 days, photoperiod sensitive-flowering after mid-December. Medium and late types occupies 30 percents of wet season planted area, respectively. (Annual Research Report 1993, 1994 Annual Research Report, Cambodia-IRRI-Australia Project)

The stable paddy production by the above mentioned hastening of the transplanting time depends on the availability of irrigation water during early wet season. If there are some tributaries in the area, the possibility of water control facilities will increase and the beneficial area will enlarge.

It is also possible to introduce upland crops in dry season, utilizing stored water during wet season. There are presently some farmers practicing dry season upland crops such as legumes by utilizing soil moisture or the stored water of small pond around their houses but they are still small-scale cultivation. With the development of water control facilities, the dry season upland cropping and the agricultural production will increase.

Some of the farmers does not have enough titled land or enough agricultural labor. It is difficult for those farmers to expand paddy cultivation but the production increase by the time shifting to cropping of upland crops is possible. Generally, upland crops consume less water than paddy so the introduction of upland crops is easier for the area with only small water resource.

(3) Agricultural Supporting Services Development

1) Agricultural Research and Extension Service

As mentioned before, DOA manages 18 agricultural institutes, such as research station, agricultural development center, rural development center and state farm, and 12 of them set paddy as the main objective crop for research activity. Among them, there are six institutes in Kandal and one institute in Takeo.

In general, the wet season rainfed paddy field is classified into five field types as mentioned before but there are no researches or surveys based on the classification till now, neither no distribution data by type. If the distribution by type is clarified on map, there are some countermeasures to reduce various damages. (For the area of (b) type paddy field, drought-tolerant varieties are recommendable and for the area of (c) type paddy field, submergence-tolerant varieties are recommendable.) In the future, land classification data should be collected through the field survey and analyzed them in detail.

For the collection of those data, well-trained field surveyor and a long term are indispensable but the present budget and staff of DOA are limited. So it is one option to train local able farmers and make them as field surveyors at some expenses.

For the rainfed agriculture development plan area, stable paddy production is the main target. To achieve the target, it needs both hastening the transplanting time and changing the varieties, from the predominant medium/late photoperiod sensitive native ones to the early photoperiod insensitive native or improved ones. It is indispensable to improve and extend varieties adopted the rainfed paddy ecosystems in accordance with the development of water control facilities, cooperated with Cambodia-IRRI-Australia Project, accumulated much useful information about paddy.

Neighboring countries such as Thailand, Viet Nam, have similar conditions on wet season paddy production. Close cooperative and exchanging information with those countries are also an effective option for aiming at stable production.

2) Agro-Processing and Marketing

This area can be characterized as paddy farming area under the rainfed condition producing most of paddy in the Study Area. Therefore, milling paddy is the prevailing agro-processing activity in the area excluding medium and large scale processing factories in Phnom Penh city. Under the present condition, commercial basis agro-processing industries might be difficult excluding ricemills because current agriculture is basically extensive farming to meet self-sufficiency by producing paddy in the vast areas. However, some crops planted in this area could be applicable to processing value-added products as shown below, in particular, oil extraction will be worth studying. Small scale processing industries are recommendable at the first stage in considering supply of raw materials and financial difficulty of farmers.

Rice bran -----extraction of oil

Maize -----animal feed

Mungbean -----noodles

Marketing of agricultural products has been done by individual farmers because of lack of agricultural cooperatives. Under the individual bargain, farmers are often at a disadvantage. For more profitable marketing, agricultural cooperative should be set up. If some difficulties or opposition will be expected among farmers, continuous explanation must be planned to explain the benefits of agricultural cooperatives. Ministry of Agriculture should take the initiative in this field.

3) Agricultural Credit

Agricultural activity in this area is dependent on wet season paddy, excluding some areas of Prey Veng in which double cropping can be practiced. Most of farmers can plant paddy only once a year in a small farm size and this resulted in low living standard which means lower income than poverty line. Institutional agricultural credit is, therefore, necessary to substitute rice deficit of poor farmers as well as facilitate and improve agricultural production. In Cambodia, NGO's credit systems have been successfully running and gradually spreading into the rural people. Under the condition, Rural and Agricultural Development Advisory Group discussed the policy and strategy of rural credit and following were agreed on beginning of September 1996:

- giving farmer and poor people the ability to get credit,
- give credit for agricultural activities,
- this credit should be available throughout the country,
- allow private banks to support rural credits as much as possible,
- update rural development credit in keeping with the privatization principle,
- continue sourcing assistance for rural credit activities.

The government and authorities concerned to rural development are required to develop and promote institutional agricultural services in the whole country as soon as possible by involving ideas and experiences of NGOs.

E.4 AGRICULTURAL DEVELOPMENT TARGET

Based on the statistical data of the concerned districts, the planted area and production data of each zone are estimated in accordance with its area distribution to the zone. The agricultural characteristics of each zone are derived from the modified statistical data and the thirteen zones are classified into five types by cropping pattern. They are as follows (see Table E.4.1 and E.4.2 and Figure E.4.1 and E.4.2).

Type	Cropping Pattern	Zone
A	Paddy in Wet Season	3, 4, 8
B	Paddy in Wet or Dry Season	5, 11, 13
C	Paddy + Upland Crops in Wet Season	1, 2
D	Paddy + Upland Crops in Wet or Dry Season (Wet Paddy > Wet Upland Crops)	6, 7, 9
E	Paddy + Upland Crops in Wet or Dry Season (Wet Upland Crops > Wet Paddy)	10, 12

From the viewpoint of cropping season, Zone 1, 2, 3, 4 and 8 are highly concentrated on wet season farming. From the viewpoint of practiced crop, Zone 3, 4, 5, 8, 11 and 13 are highly concentrated on paddy.

As for land productivity, the yield of paddy and maize are computed by each zone. Some of the yields of other crops are not analyzed because it seems that the production amount are calculated from the multiplication of the cultivated areas and the fixed provincial yields. Generally, the yields of both wet and dry season paddy in Type D and E are higher than those of other areas. On the other hand, paddy monoculture areas, Type A and B, have the lower yields of both wet and dry seasons than the averages. Maize yield varies with cropping season and zone, but Zone No. 6 and 7 have higher yields of both wet and dry seasons than the averages (see Figure E.4.3).

Some of the agricultural characteristics, derived from the Rural Socio-Economic Survey and statistical data, are as follows;

- (1) Kampong Cham has a lot of upland fields producing tobacco. This fact implies that there is fewer available irrigation water than in other areas.
- (2) Vegetable is broadly cultivated in Zone 7 and 9 in both wet and dry seasons, but in Zone 6, mainly in wet season and in Zone 10, mainly in dry season.
- (3) Although the average titled farmland per farm is affected by locality, the introduction rate of upland crops is largely influenced by the three farm types of paddy cropping season.

Based on the various data, the present agricultural characteristics of each zone, natural conditions and accessibility to the market and so forth, the basic farming development concepts are proposed as follows: (see Table E.4.3)

- Projected cropping patterns will be same as the present five ones but their application to each zone/district varies with the development degree of agricultural facilities, in particular irrigation facilities.
- Although paddy is a staple food for Cambodia, the yield is still lower than in neighboring countries (Cambodia-1.79 ton/ha (1995), 1.06 (1994), Thailand-2.15 (1994), Laos-2.59 (1994), Vietnam-3.46(1994) ton/ha, [Selected Indicators of Food and Agriculture Development in Asia-Pacific Region, 1984-1994, FAO, 1995]). This may come from the fact that the native varieties represent the majority of the wet season paddy planted area and keeping rice seed for themselves common among farmers. Accordingly, it is necessary for all zones to start varietal improvement to develop the superior paddy varieties adapting local natural conditions.
- As for paddy production, the average yields of both wet and dry season paddy in the Study Area are higher than the national averages. Consequently, both average yields of the Study Area are set as the first attainable target for the zones which have lower yields (wet season paddy: Zone 1, 2, 3, 4, 11, 12, dry season paddy : Zone 1, 2, 5, 7, 11).
- Based on the results of the past research and survey, the target yield for short/medium term dry season paddy varies between 3.0 to 4.3 ton/ha depending on zone. That of wet season paddy is set as 1.85 ton/ha.
- Dry season paddy, with higher productivity than wet season paddy, should be expanded in the areas where there is possibility to develop water resource (Zone 1, 2, 6, 7, 9, 10, 12).
- In accordance with one of the national agricultural policies; crop diversification, the introduction of upland crops should be promoted in the whole Study Area but the introduction of vegetables should be limited for the areas around Phnom Penh (vegetables introduction : Zone 3, 6, 7, 8, 9, 11).

It is estimated that total paddy production of the whole zones, derived from the target yields and planted areas, is expanded to about 1.8 million tons.