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Dynamics of Latex Production and Relative Productivity of Small-holders

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Dynamics of Latex Production and Relative Productivity of Small-holders

by

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ABSTRACT

This paper estimates the relative productivity of rubber small-holders and their revenue variation in one production cycle. Plasma farmers from the Nucleus Estate Small-holder Project in Alue Ie Mirah represent small-holders. The study finds that small-holders could produce approximately 23.3 tons per hectare in 16 tapping years, while government owned estates produce 34.6 tons per hectare in 25 tapping years. These differences are mainly due to inter-temporal decisions regarding the intensity of tapping systems and cultivating systems such as application of fungicides, fertilizers, stimulants and weed control over the latex production cycle.

ABSTRAK[5]

Tulisan ini mencoba untuk memperirakan produktivitas relatif dari perkebunan karet rakyat dan keragamannya dalam satu periode produksi. Petani plasma dari proyek Perkebunan rakyat di Alue Ie Mirah diambil sebagai contoh yang mewakili perkebunan rakyat. Hasil penelitian ini menunjukkan bahwa perkebunan rakyat dapat berproduksi kurang-lebih 23,3 ton pada 16 tahun penyadapan sedangkan perkebunan negara dapat mencapai hasil 34,6 ton pada 25 tahun penyadapan. Perbedaan ini terutama sekali disebabkan oleh penentuan intensitas dari sistem penyadapan dan sistem budidaya misalnya pemakaian fungisida, pupuk, perangsang dan pembasmi gulma pada dinamika alami sistem produksi lateks.

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5 The abstract for Indonesia language is kindly prepared by Reni Kustiari (Graduate Student, Department of Agricultural Economics, University of Missouri, Columbia).

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INTRODUCTION

A dynamic production system reflects the existence of multiple decisions in each time period. Decisions regarding production and input used in earlier periods influence the productivity a crop in the future periods. In latex production, while natural causes are held constant, intertemporal decisions such as the intensity of exploitation, applications of fungicides, fertilizers and weed control, determine the economic life of the plantation and the amount of latex produced in each time period. There is a general impression that the production system of small-holders in Indonesia, especially the tapping intensity, is different from those of commercial or government-owned estate plantations (PTP)[6]. Small-holders' share of total production is approximately 80% [7]. Therefore, the relative productivity of small-holders and their income from rubber during one production cycle are important in the Nation's economic development.

In this study, we estimate the economic life of a relatively small-size rubber plantation in order to evaluate the productivity and income of small-holders in a dynamic setting wherein latex production is analyzed over multiple periods.

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[6] Perusahaan Terbatas Perkebunan (Translation to English = Government Owned Plantation Co. Ltd.).

[7] Dereinda, R. et. al. Prospects for sheep Husbandry and Socioeconomic Constraints in the Nucleus Estate and Smallholder Project in Indonesia. Proceedings of a Workshop on research Methodologies Medan, North Sumatra, Indonesia, September 9-14, 1990. Edited by L.C. Iniguez and M. D. Sanchez.

There are primarily two different types of small-holders in Indonesia; plasma and traditional farmers. Plasma farmers are those who receive from the PTP, 2 hectares of rubber plantation and, depending on the type of project[8], some may receive (0.75) hectare for food crop production and (0.25) hectare for their home yard. The size of plantation cultivated by traditional farmers varies from less than 1 hectare to 15 hectares. Besides, there are many differences between the quality of plantation operated by plasma and traditional farmers. Plantations of plasma farmers are systematically cultivated with high yielding clones, equally spaced and of the same age, whereas, according to local scientists, most of the plantations managed by traditional farmers are unselected seedlings with no systematic spacing and with mixed ages of trees. Therefore, for research purposes, plasma farmers are chosen to represent small-holders in this study.

In the following sections, we first present the analysis of aggregate latex production pattern of plasma farmers to compare with that of an average government owned estates in North Sumatra. Second, revenue variations over one cycle are investigated to study the sustainability of small-holders in the rubber industry.

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8 These projects are named as Nucleus Estate Smallholder (NES) rubber plantation projects.

MATERIAL AND METHOD

Study Area

The data[9] used in this study was collected from Alue Ie Mirah, Aceh, which is one of the earliest Nucleus Estate Smallholder (NES) rubber plantation projects in Indonesia. Planting dates range from 1977-78 to 1986-87 excluding the year 1984-85 and 1985-86, when no trees are planted.

Although each farmer is assigned two hectares, due to topography the number of trees each individual receives varies from 350 to 900. It is absolutely essential that analyses give attention to those major differences. In order to calculate costs more efficiently, eleven different farm sizes are categorized as class A through D2, where A represents the highest number of trees and D2 the lowest number of trees (table 1). Similarly, the size of credit ranges from three to seven million Rupiah without interest. The credit is provided by the World Bank through one of Indonesia's national banks. The loan recovery period is up to 15 years with 10.5% interest per year. After one or two years of tapping, 30 percent of the latex from each harvest is collected by PTP as credit repayment.

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9 We collected both primary and secondary data from Alue Ie Mirah. The primary data is used for the estimation of number of tapped trees over time in this study. The detailed procedure of data collection is explained in "(a) Number of Tapped trees", on page 6.

Participant farmers are both local and transmigrant[10]. All plasma farmers in Alue Ie Mirah produce coagulated latex (cuplump). Most of the activities such as selling cuplump and growing food crops are done collectively. There are about 20 farmers in a group. Each group has an appointed leader who gathers cuplumps from his group and sends it to the processing factory where price is determined according to the dry rubber content. The next day after cuplumps are sent to the factory farmers receive the revenue for their rubber through the leaders.

Methodology

Since the earliest planting date is 1977-78, and trees generally are tapped after six or seven years of age, the actual production data is available as far back as ten years, and the production cycle has not been completed yet. In this analysis production data for the whole production cycle is required to study the relative productivity of small-holders. Therefore, for analytical purposes, the remaining potential productivity in terms of grams per tree per tapping will be estimated based on the previous actual aggregate production, bark consumption per tapping, the length of left-over bark available to tap, condition of the bark, exploitation system applied, and the number of tapped trees.

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10 Government of Indonesia has been implementing the transmigration program which transfers people from over-populated Java to other Islands and helps settle them in new areas.

In our paper, previous aggregate production data for the earliest planting date 1977-78 is analyzed and its potential dry rubber production is estimated to study the yield pattern of one cycle. The formula for calculation of production per hectare per year is as follows;

$$Y_t = N_t \times D_t \times P_t$$

where,

Y_t = Production per hectare in year t

N_t = Number of tapped trees per hectare in year t[11]

D_t = Number of tapping days in year t

P_t = Production in grams per tree per tapping in year t

After this, revenue per hectare for one production cycle is calculated by simply multiplying yield per hectare and farm gate price. Since the farm gate price from Alue Ie Mirah is available for only for 1990 to 1993, the domestic market prices [average prices for Ribbed Smoke Sheet-grade 3 (RSS III)] in PTP 1-9 in Sumatra and Aceh)[12] is used for the period 1984 to 1989. In determining the estimated revenue of plasma farmers for 1994 to 1999, the average of previous prices is used as an approximation.

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[11] N_t = (Area tapped in year i / Total Area Planted) * Total Number of Trees planted * Percent of Tapped Trees in Year t.

[12] Kantor Pemasaran Bersama (PTP 1-9) Sumatra and Aceh, 1984 to 1989.

Estimation

(a) Number of Tapped Trees

The number of productive trees associated with the year of tapping is estimated from the field both by interviewing farmers and by tree census. Generally, the grace period for each tree is not uniform. Hence, during the first few years of tapping, the number of tapped trees will be less than the total stand. While the number of mature trees increases over time, the tapped trees may be reduced due to tapping panel dryness as a result of an intensive tapping system or other factors such as wind damage, white root disease, etc.

Therefore, the rate of change in the number of tapped trees within one production cycle is necessary to calculate for this analysis. Since there are eight different stages of planting dates in the study area, ten farmers[13] from each stage are asked to answer questions about such factors as, the total number of trees they receive, the number of trees tapped in the first year and the number of trees now being tapped. Among trees counted as not being able to tap are dry trees, fallen trees, and immature trees. When farmers are not sure of how many tree they are tapping, we conducted a tree census. Then, from the number of tapped trees in each stage, the rate of change in the number of

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[13] The majority of the farmers we surveyed were those suggested by PTP officials and we noticed that their current level productions were relatively higher than the rest of the farmers in the area.

tapped trees is determined for the whole production cycle (Figure 1).

(b) Tapping System Applied

In most of the NES-rubber projects, suggested tapping intensity may not be realized because it depends on the individual's or family's socio-economic behavior, experience and is directly associated with the buying power. The exploitation system suggested by PTP is (1/2 S d/2)[14]. In our estimation, we utilize (1/2 S d/1 6d/7)[15] based on field observations and discussions. We realize that any error made in the estimated level of tapping intensity will influence the projected economic life of the trees in the plantation. For example, if the high intensity exploitation system is applied in the analysis, the estimated economic life of the plantation will be shorter than that of low intensity exploitation system[16].

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[14] Half spiral cut, tapping every two days.

[15] Half spiral cut, everyday for six out of seven days.

[16] A comment on the first draft of this paper by Mr. Noersalim (Director of Development Division, PTP I, Aceh), dated February 22 1994, stated that the relatively high intensity exploitation system was a result of the lack of experience in the plantation. And said.." We have changed tapping system (1/2 S d/1 6d/7) to (1/2 S d 4/7) (half spiral cut tapping, four days every seven days in a week)".

(c) Bark Consumption and Bark left

In Alue Ie Mirah, bark consumption for downward and upward tapping is 1.5 mm and 1.7 mm per tap, respectively[17]. Therefore, a tapping intensity of (1/2 S d/1 6d/7) = 240 tapping days per year implies 36 cm for downward and 41 cm for upward tapping used annually. For evaluating the left-over productive bark, we refer to the book published by the NES project in Alue Ie Mirah, Aceh[18] and actual inspections in the field. The tapping height is measured from the tappable bark above the union-foot. In two panel systems, usually referred as panel BO-1 and BO-2, each starts from 130 cm from the union of the stock and scion. The first renewed bark, panel BI-1 and BI-2, tapping heights are 130 cm for both. However, most of the plasma farmers opened the first and second renewed barks from 150 cm from the union-foot.

Usually, panel BO-1, BO-2, BI-1 and BI-2 are tapped with a downward tapping system. After tapping low panels, an upward tapping system begins from 130 cm towards as high as 300 cm and above for both panels, namely HO-1 and HO-2[19]. Therefore, depending upon the intensity of exploitation system, the bark

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[17] Sunarwidi et. al. Masalah Penyadapan Di Proyek Pengembangan Karet Rakyat Dan Alternatif Pemecahannya (1988).

[18] BuKu Induk, Proyeksi TaTa Guna Kulit Sadap, Bark Consumption. Instruksi Direktur Utama. No.01.1/Kbn/Instr/11/1992

[19] Tapping panel notations are of international notation.

consumption and production cycle will vary accordingly.

The worksheet is presented as table 2 and actual and estimation of grams per tree per tapping for one production cycle is illustrated in figure 2. In estimation of grams per tree per tapping, we used the yield of double cuts (combining one cut in the high panel and one in the low panel), for 14th and 15th years of tapping. Because, local scientists observe that when the amount of latex per cut declines due to the poor condition of renewal bark and the location of bark in a tree, farmers generally practice double cuts to increase the current earnings.

RESULTS AND DISCUSSION

Productivity

Trees from the planting date 1977-78, with GT 1 clone, are ten years in production and have already produced 13.43 tons per hectare. We estimate that the plantation will last six more years with 9.8 tons dry rubber per hectare. Suhendry and Alwi[20] reported that for GT 1 clone, an average of government owned estate plantations (PTP) in North Sumatra is 13.08 tons per hectare in ten years. However, its productive life is 25 years with total dry rubber production of 34.06 tons per hectare (Figure 3). These differences are the result of soil, weather, planting system, management practice, tapping skill and socio-

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[20] Suhendry, I. and Alwi, N. Produktivitas Kebun Dan Trend Produksi Klon. Prosiding, Konferensi Nasional Karet 1990, Palembang - Indonesia 18-20 September 1990. Buku II.

economic behavior of farmers which in turn influence the exploitation system.

The variations in soil, weather, and planting system are minimal among the plantations of small-holders and that of PTP. Because, Alue Ie Mirah is selected by the government as one of the NES projects for her favorable environment condition for rubber production. In addition, from the date of land preparation until the trees are ready to tap, PTP supervises the planting system. Therefore, we emphasize on the impact of the cultivation system in the mature period, exploitation system, and socio-economic behavior of individuals on yield differences between small-holders and PTP. The discussion is presented in the following sections.

(a) Cultivation Practice

After maturity, maintenance of the plantation includes fertilization, pest and disease control, and weeding.

(1) Fertilizer requirements for rubber depend on the type of soil, age of trees, type of cover crops during immaturity period, exploitation system and interactions between these conditions. Rubber trees are more responsive to fertilizer on poor soil and during their immature period. Experimental results indicate that with fertilizer application, the grace period before tapping is reduced from eight years to five years compared to that of

control plots[21].

For a mature rubber tree, fertilization is used to increase the production and mainly to achieve sustainable growth. Here, poor soil and deficient renewal barks are found to be the necessary conditions for fertilizer application. If pure legume covers are planted during the immature period, nitrogen application can be withheld until early tapping years[22]. Mature trees are more responsive to N than other nutrients, sometimes with the presence of K and Mg, becoming effective at 3 to 6 years after application and reaching a maximum of 11-58 percent after 8-10 years[23]. A research project carried out in Indonesia, where the GT 1 clone was planted on yellowish brown podzolic soil, concludes that the effect of N, P, and K on mature rubber tree during the first four years is not significant[24].

In summary, the above studies suggest that if the plantation is under a well cultivated system during the immature period, fertilizer application can be started at four years after commencement of tapping. And the nutrient status of the trees should be monitored at 3-5 years interval. In our study area,

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[21] Dijkman, M. J. Hevea, Thirty Years of Research in the Far East. University of Miami Press. U.S.A. 1951

[22] Pushparajah et. al. Recent Developments for Reduced Fertilizer Applications for Hevea. Proceedings of RRIM Planters' Conference. 1983.

[23] Webster, C. C. & Baulkwill, W. J. Rubber . Longman Scientific Technical. New York. 1989.

[24] Taryo & Adiwiganda. Bull. BPP Medan, 1979, 10 (1)

fertilizer was provided by PTP only in the earlier tapping period. During the later years of tapping, the maintenance of the plantation is the individual's own responsibility with guidelines from PTP. We observe that only a few farmers regularly apply N, P and K fertilizers.

(2) Many fungi particularly the mouldy rot can attack plants only through wounds, and may cause serious damage to a tree. In production of latex, the tapping panel is being continually and repeatedly injured, hence fungi can easily enter, especially in times of heavy rainfall and high humidity. Therefore, annual fungicides application is necessary for the study area. Although the majority of farmers in Alue Ie Mirah are applying fungicides annually, bark-lost due to fungi attack is common in the study area.

(3) Weed control is a necessary task during the immature period to reduce the grace period. When rubber trees are bringing into tap after six or seven years of planting, weeds become their competitors for nutrients from the soil. However, there has not been any study analyzing the significance of variation in latex yield due to weeds under the rubber trees[25].

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[25] Personal communication with Ir. Tuti (Research Scientist for Weed) from National Center for Rubber Research Institute in Indonesia.

(b) Exploitation System

Studies reveal that there is a significant negative relationship between girth increment and exploitation intensity. In untapped trees, synthesized carbohydrate is utilized only for vegetative growth. When trees are tapped, carbohydrates contribute to both latex production and vegetative growth. Hence, the higher frequency of tapping reduces as much as 50% of the shoot dry weight and the girth increment as compared to untapped trees. As a result, the high exploitation intensity causes a gradual changes in weight distribution between crown and stem with the weight shifting more towards the crown, creating, therefore, more susceptibility to wind[26].

In our study area, where the majority of farmers practice a high intensity exploitation system, we observe that there are high rates of tree loss due to falling. However, we can not positively conclude whether or not it is a result of a high intensity exploitation system, because most plantations in Aceh and North Sumatra are infected with white root disease which eventually uproots the trees.

(c) Socio-economic Behavior of Farmers

Each individual brings unique family background, experience and circumstance, which affect the management of family resources in various stages of production system. In rubber production,

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[26] Webster, C. C. & Baulkwill, W. J. Rubber. P-383. Longman Scientific & Technical. New York. 1989.

tapping practices can vary from as frequent as two times a day to once in a month or more, the above factors make it difficult to rationalize how much each individual will produce at a certain stage.

In the literature on dynamic resource exploitation, theory predicts that if the interest rate is relatively higher than the rate of return from rubber each year, it is more economical for a farmer to exploit as much latex as possible in the short run with due consideration given to future expected returns. Following rational behavior, a farmer will vary the tapping practice according to the prevailing interest rate but future expectations are also important. In the study area, there are no private money lenders in the villages because the religion prohibits an interest rate charge on the credit. Additionally, many banks in Aceh require borrowers to clear the first loan, which is for the plantation each farmer receives, before getting another loan. Hence, we have not been able to determine whether or not the high intensity tapping system is partly due to investment opportunities.

In conclusion, factors contributing to differences in total production and length of production cycle of small-holders and PTP appear to result from the intensity of tapping system, tapping skill and cultivation systems. Compared to small-holders, the PTP reportedly practices a lower intensity tapping system with stimulants, and relatively better cultivating systems in the mature period. As a result, small-holders may produce a

total of 23.25 ton per hectare over 16 years whereas PTP produces 34.60 ton per hectare over 25 years.

Further analysis are recommended to investigate the relative economic efficiency of small-holders. This study is only the first step in determining the efficient exploitation of latex over its production cycle. The programming analysis may be able to include as many as possible of above-discussed factors. Data on changes in the number of tapped trees over time, the influence of exploitation intensity on yield, and production costs are critical in evaluating the economic efficiency of rubber production, mainly because of its dynamic nature. Therefore, conducting research to analyze such data should be a priority, considering the significance of small-holders in the country's economic development process.

Revenue

Regarding earnings from rubber, as yield changes throughout the years of tapping, revenue closely follows the production. Revenue from one hectare of rubber in the **first year** of tapping is the **lowest:** Rp. 200,000[27] (US$ 1 = Rp. 2000). The **highest** revenue is approximately 2.7 million per hectare in the **ninth**

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[27] In October 1993, prevailing prices in the study area are: Rice; 1 Kg ~ Rp. 600, Fish; 1 Kg ~ Rp. 2500, Beef; 1 Kg ~ Rp. 5000, Eggs; 1 = Rp. 150.

year of production[28]. From the second year to the sixth year, the income is relatively lower than the in rest of the tapping years (Figure 4). Besides, when there is a profound seasonal yield changes within one year, so does the revenue changes in similar fashion.

Therefore, the alternative sources of revenue to stabilize small-holders rubber farmers' income could prevent them from practicing poor cultivation systems. Considering the significant share of small-holders' in total rubber area, and the instability of their income, enterprise diversification for them is important for the sustainability of the rubber industry in Indonesia.

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[28] Note that 30 percent of the each sale is for credit repayment, which was began to collect two or three years after tapping commencement after the debt is fully repaid with interest.

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Bellman, R., Dynamic Programming. Princeton, N. J.: Princeton University Press, 1957.

Bellman, R. and S. Dreyfus, Applied Dynamic Programming. Priceton, N.J.: Priceton University Press, 1962.

Chiang, Alpha C. Elements of Dynamic Optimization. McGraw-Hill Book Company. 1992.

Conrad, Jon M. and Clark, Colin W. Natural Resource Economics: Notes and Problems. Cambridge University Press. 1991.

Proceedings of the Sixth Seminar Held in Palembang, Indonesia 22-26 July, 1986. The Progress and Development of Rubber Small-holders.

Table 1. Farm Sizes in Alue Ie Mirah

Class	No. of Trees in Two Hactare
A	> 780
B	738 - 779
B1	696 - 737
B2	654 - 695
B3	612 - 659
C	570 - 611
C1	528 - 569
C2	486 - 527
D	444 - 485
D1	402 - 443
D2	360 - 401

Table 2. Dry Rubber Production Overtime (Planting date 1977-78)
Actual Production - From 1st to 10th Year
Estimated production - From 11th to 16th year

Years of Tapping	Area Tap (Ha)	No. of Trees Planted	% of Tapped Trees	No. of Tapped Trees	Dry Rub Prod. (Kg)	g/t/t*	Dry Rub Prod. Kg/Ha/ Year
1	152	109618	72.6	33416	55030	6.86	362.04
2	328	109618	74.0	73499	349818	19.83	1066.52
3	362	109618	75.0	82214	410276	20.79	1133.36
4	362	109618	76.0	83310	341686	17.09	943.88
5	362	109618	79.9	87563	545180	25.94	1506.02
6	362	109618	82.4	90369	273486	12.61	755.49
7	362	109618	85.0	93175	633166	28.31	1749.08
8	362	109618	81.7	89514	790411	36.79	2183.46
9	362	109618	73.7	80734	778226	40.16	2149.80
10	362	109618	66.7	73115	572957	32.65	1582.75
11 @	362	109618	60.7	66538	443197	27.75	1224.30
12 @	362	109618	54.7	59961	559137	38.85	1544.58
13 @	362	109618	48.7	53384	497803	38.85	1375.15
14 @	362	109618	42.7	46807	785650	69.94	2170.30
15 @	362	109618	36.7	40230	607727	62.94	1678.80
16 @	362	109618	30.7	33653	660880	81.83	1825.63

Opening Year: 1984
* = Gram per Tree per Tap
@ = Estimation

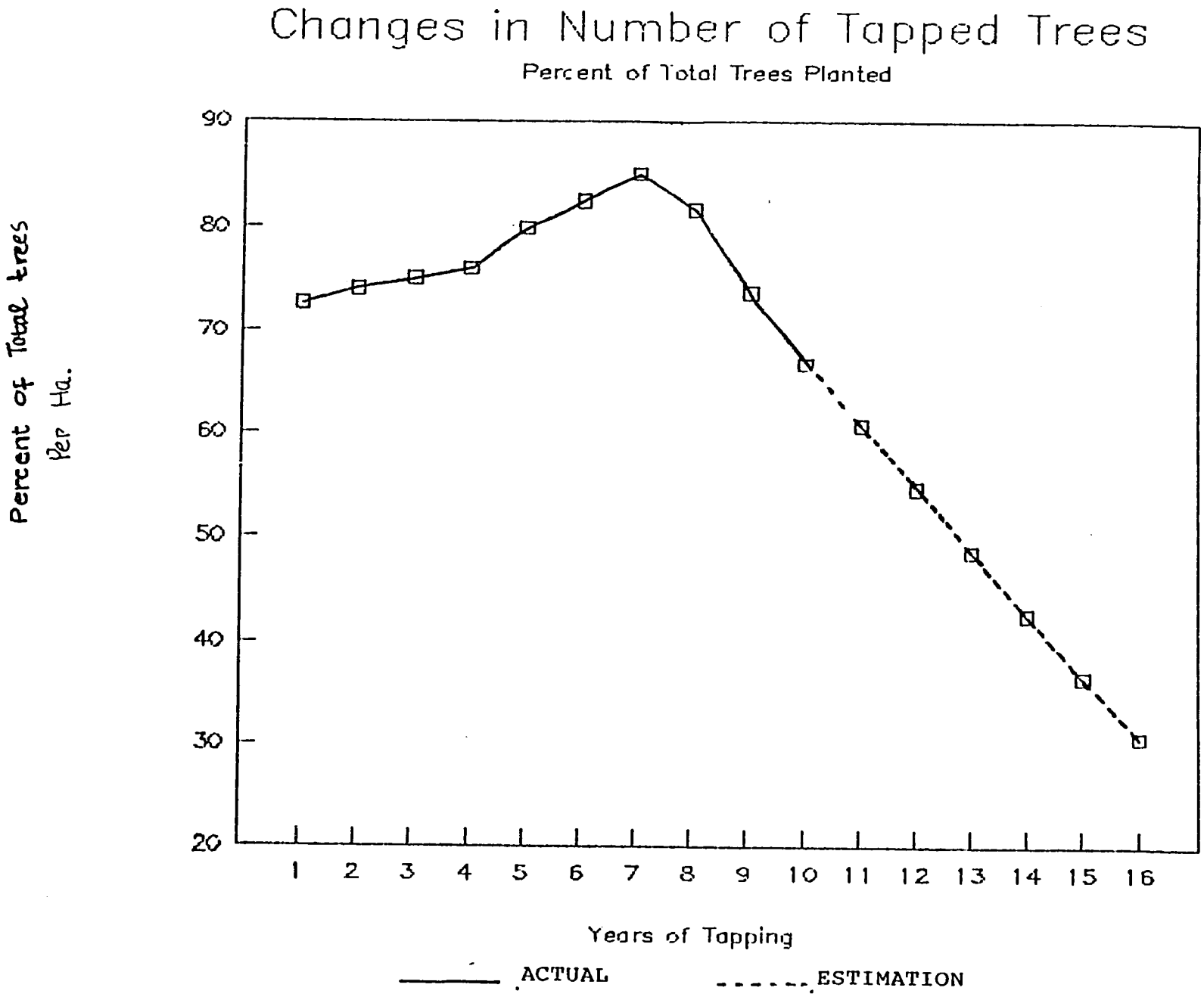
Tapping System

11th year : 1/2 S d/1 6d/7 with single cut
12th year : 1/2 S d/1 6d/7 "
13th year : 1/2 S d/1 6d/7 "
14th year : 2 x 1/2 S // d/1 6d/7 (double cuts)
15th year : 2 x 1/2 S // d/1 6d/7 (")
16th year : Free tapping

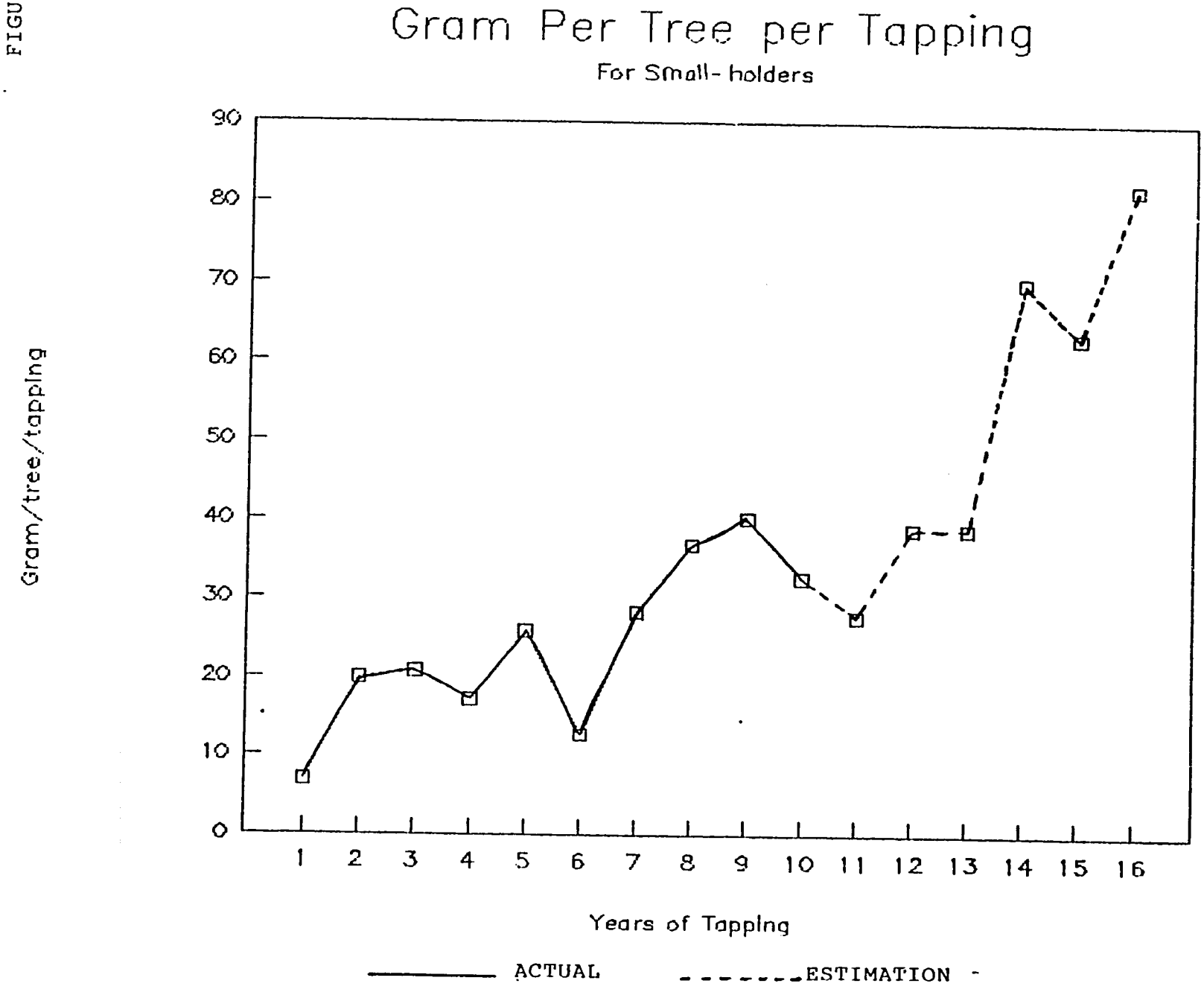
Bark Consumption

Downward tapping = 1.5 mm/tap
Upward Tapping = 1.7 mm /tap

APPENDIX 3
FIGURE 1

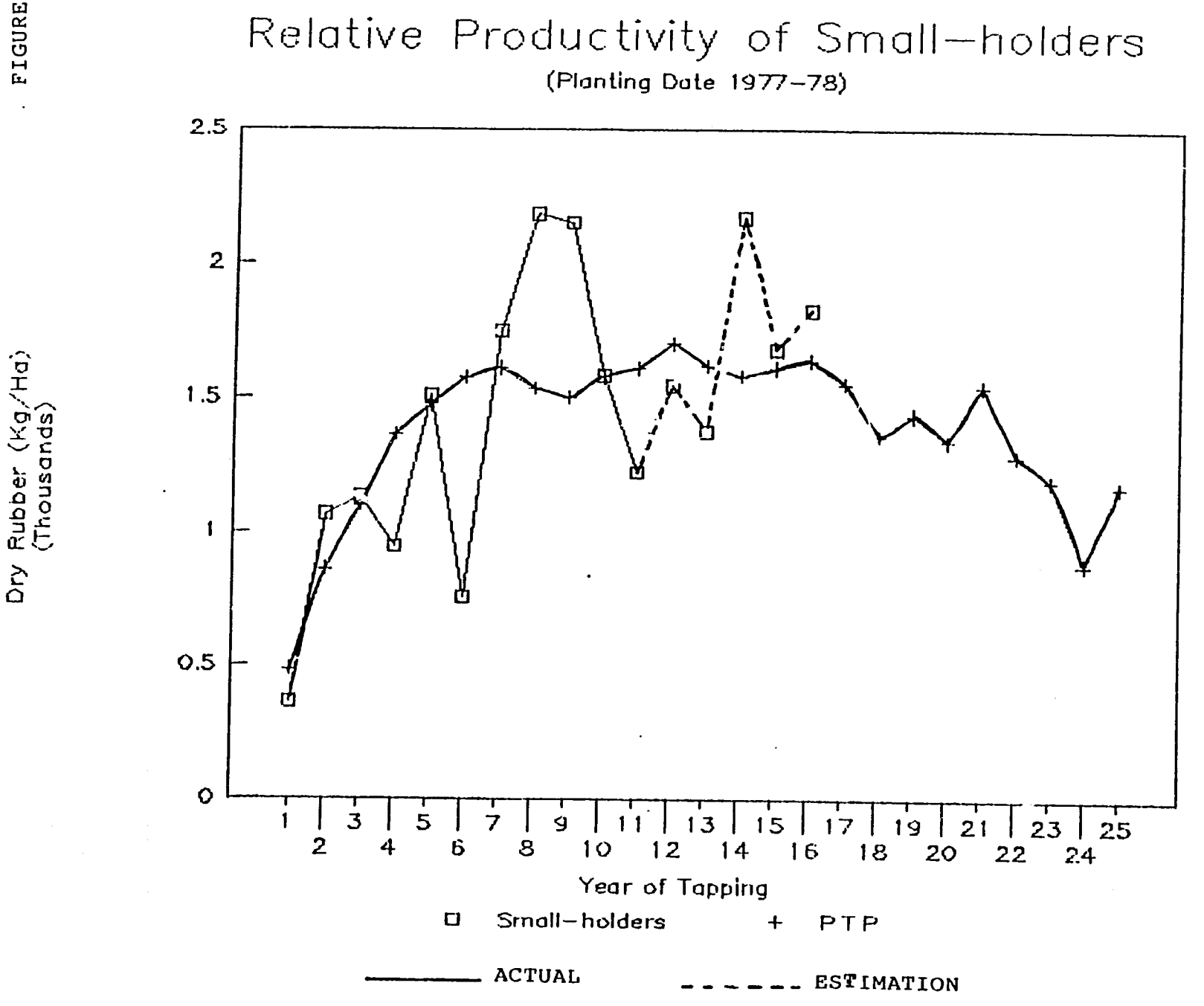
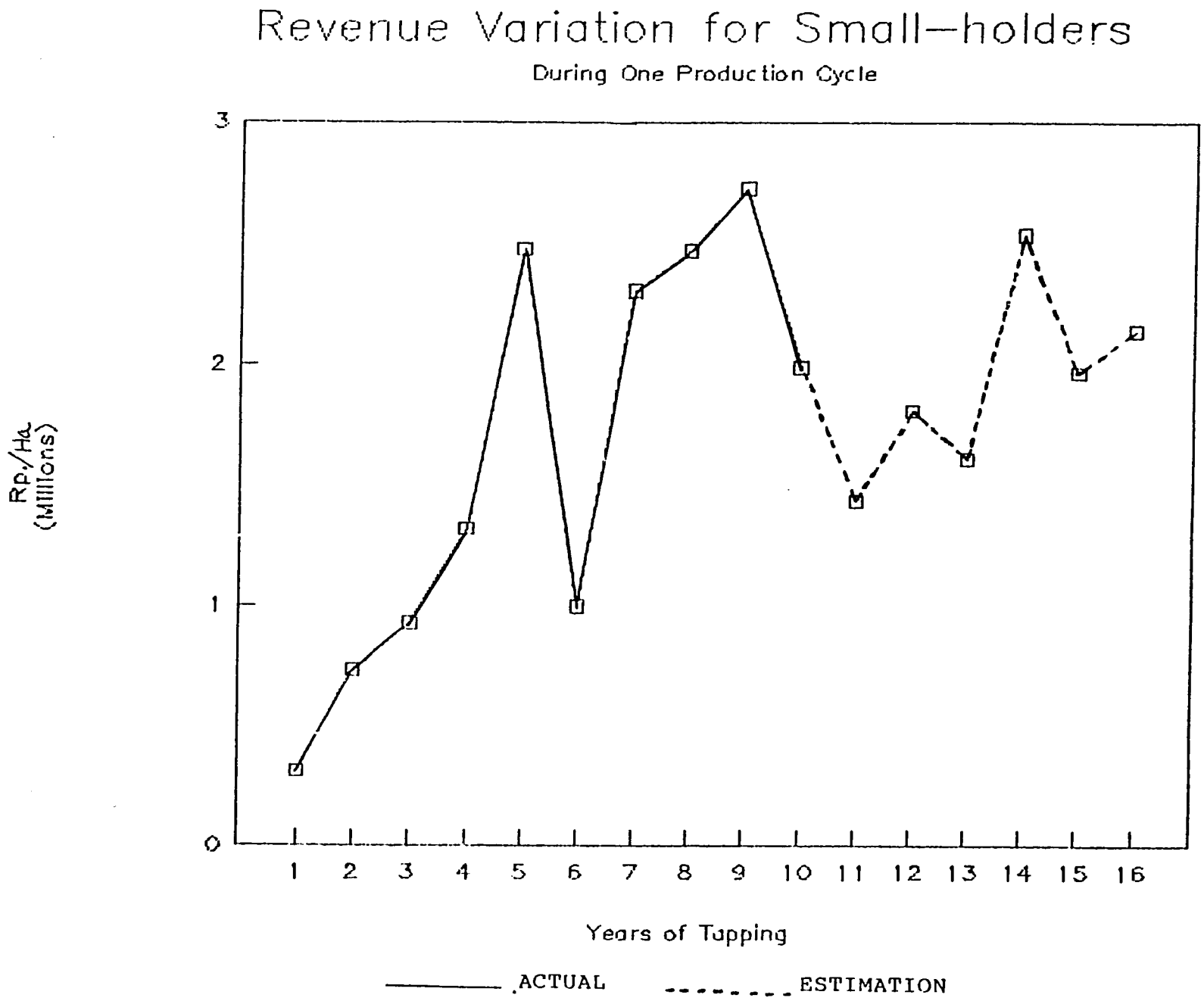


APPENDIX 4
FIGURE 2



APPENDIX 5

FIGURE 3



APPENDIX 6
FIGURE 4