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ACHIOTE, A PROMISING ALTERNATIVE FOR INCLUSION IN SMALL FARMING SYSTEMS

by

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Abstract of Achiote Prefeasibility Study

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Achiote (or Annatto) seed is produced by a small bush type tree that grows to a height of 10-12 feet when left untrimmed; its botanical name is Bixa orellana. Achiote grows wild in many parts of the Americas between 25º North Latitude and 25º South Latitude. Most achiote varieties produce hairy or bristly looking pods filled with from 10 to 50 small seeds, about the size of grape seeds. The seeds are coated with a red-orange waxy substance (Bixin) possessing a high degree of color capability. The colorant may be extracted from the seeds in a variety of ways and is used as a food colorant and flavor carrier in local and export markets. Achiote colorant's demand has grown in pace with the food industry in the US and many other countries. It is used in a variety of products such as: cheese, ice cream, food snacks, breakfast cereals, butter, oleomargarine, etc. In addition to serving as a colorant, achiote extract is high in Vitamin A. Research being conducted at the University of Costa Rica is investigating use of the entire pod for animal concentrates. The dried seeds with hulls contain approximately 25% digestible protein when fed to cattle, goats, horses or sheep.

Local processing of the colorant in Costa Rica at the farm level is accomplished by placing the seeds in water and stirring until the colorant dissolves. This is done before the pods and seeds dry out because after the seeds dry, the bixin is no longer water soluble. The mixture is then strained to remove the seeds and boiled to remove excess water. As excess water is boiled away, the mixture thickens, and is allowed to cool, placed in bags, and hung up to dry. After hanging approximately one week it is sold as "paste".

√ The major topics and/or conclusions presented in this study are enumerated below.

1) The study begins by describing a typical farming system in the Quepos area. This sets the stage for subsequent analysis which will be related to the situation of this typical farmer with 10 hectares of land, 10 family members, and a set of typical cropping systems.

2) Analysis of current cropping systems shows that a typical family could grow as much as 4 ha of traditional achiote and still produce more corn, beans and rice than the family needs for on-farm consumption.

3) Using current farm level prices, traditional achiote production has a net value of production per hectare of ¢ 2685. This is ¢ 85 higher than beans, ¢ 632 higher than rice and ¢ 702 higher than corn. Net value of production per hour of labor effort for traditional achiote is 7% higher than beans, 291% higher than rice and 218% higher than corn. Net value of production per ¢ invested in traditional achiote production is 688% higher than beans, 1843% higher than corn and 3024% higher than rice. The total net value of production for all crops in a typical farming system which includes intensively grown achiote is 47% higher and uses 31% more labor than the typical farming system composed of corn, beans and rice.

4) Achiote prices and demand appear to be increasing on world markets. Prices farmers currently receive are high enough to make achiote production more attractive than corn, bean, and rice production and low enough to permit Costa Rica to enter export markets (given existing prices and costs).

5) A research program is needed to provide more information on a variety of questions such as: the dried seed value and yield of different varieties; the labor requirements, costs and yields associated with

more capital, labor and chemical intensive production; the actual costs and potential problems involved in drying, packing and exporting seeds; and the likelihood of increased demands for achiote in animal concentrates. Each of these questions is important for future expansion of achiote production; in spite of these unanswered questions, the overall picture for achiote appears favorable.

6) The cooperative needs to obtain price and quantity commitments from potential buyers as soon as possible to determine what price the cooperative can afford to pay for recently elaborated paste and still remain solvent. Until these agreements are reached, it would be wise to limit initial farmer payments to no more than the current normal price of ¢18/lb for recently elaborated achiote paste.

7) The cooperative should not pressure farmers to adopt capital, labor and chemical intensive technologies until more is learned about costs and yields.

8) Additional achiote plantings by individual cooperative members should be restricted to a maximum of 1 ha this year because of uncertainties regarding increased demand.

9) Seed analysis to ascertain bixin content of different varieties and different locations should be undertaken at once. Trial shipments of dried seeds in 10 MT quantities should be initiated as soon as possible to learn more about export possibilities and problems.

10) The cooperative should not limit its activities to achiote production and marketing, but should instead become a focal point for a variety of production, marketing, technical assistance, home economics and adult education activities.

11) Inclusion of achiote in small farm systems reduces various kinds of

risks and adds stability to the system by evening out the farmer's annual labor requirements pattern and hence decreases management risks. Achiote spreads marketing risks by diversifying the farmer's set of products and reduces weather related risks because it is a hardy plant once established.

12) Achiote helps control erosion on steep slopes where farmers are currently planting annual crops.

13) CATIE would be a natural focal point for achiote investigations because of its established relations with MAG, its experience in working with small farming systems, and the fact that it has an established collection of achiote varieties that represent an invaluable source of raw material for propagating promising varieties. Consequently, INFOCOOP should negotiate a joint research contract with CATIE and MAG to provide research funds needed for materials, laborers, etc., as soon as possible.

14) Although this paper deals specifically with achiote, it also provides a methodology for analyzing how other perennial crops could fit into a small farming system and how inclusion of perennial crops reduces risks, increases income and increases labor utilization rates for small farm families.

ACHIOTE, A PROMISING ALTERNATIVE FOR INCLUSION IN SMALL FARMING SYSTEMS

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On August 24 and 25, 1976, I visited Neal Byrd, Gerente of the Marketing Cooperative being formed in Quepos. The purpose of this trip was to gain a better understanding of the importance of achiote production as a component of small farm cropping systems, and to learn more about the cooperative and its plans for the future.

On this trip, Mr. Byrd explained that the cooperative would like to stimulate increased achiote plantings because they have received a letter from KALSEC, Inc., a Kalamazoo, Michigan, based firm which would be interested in constructing an achiote extraction plant in Costa Rica provided there is sufficient achiote production to warrant building the plant. Sufficient production in this case would be a minimun of 400 tons of raw material or roughly 3.5 times current production in the Quepos and San Isidro del General areas. KALSEC's interest represents an opportunity for the cooperative but also raises some questions such as: (1) How many additional hectares would be needed to produce an additional 385 tons of achiote, and how many farms would be involved? (2) What price should the cooperative pay farmers to induce them to increase their achiote plantings? (3) Should the new achiote plantings be of the same type as existing traditional plantings or should they be more technified plantings with emphasis on use of fertilizers and herbicides?

During the visit to Quepos, we were able to attend a small farmer extension meeting, arranged by Ing. Hector Madrigal, a local extension agent. At this meeting, some basic production, yield and cost data was collected, which allows one to understand the types of systems currently being used by typical small farmers near Quepos. This basic data has been followed up by further investigations, and the original set of questions proposed during the visit to Quepos has been redefined and expanded into a set of eight questions which will be dealt with in this paper.

The questions are:

1. How does achiote fit into a small farmer's cropping system?
2. How much achiote can the typical family cultivate?
3. Does traditional achiote production have sufficiently high ₡/ha and ₡/hr returns to make it worthwhile for farmers to increase achiote production?
4. What are the prospects for selling achiote in export markets, and what price can the cooperative expect from export sales?
5. What price should the cooperative pay its members for their achiote this year?
6. If achiote were produced in a technified manner, what effect would this have on yields and farmer incomes?
7. Should the cooperative finance traditional and technical achiote plantings or only technical achiote plantings?
8. How many additional hectares of achiote should the cooperative finance?

How does Achiote fit into a Small Farmer's Cropping System?

At present, the most important crops being cultivated by small farmers in the Quepos area are corn, beans, rice, and achiote. Achiote production is usually limited to a hectare or less, but farmers expressed a willingness to increase production if they had a secure market and an attractive price. Rice production is usually also limited to a hectare or less, while corn and bean production will generally fluctuate between 1 to 5 hectares depending on farm size, family size, prices, etc.

Two crops a year

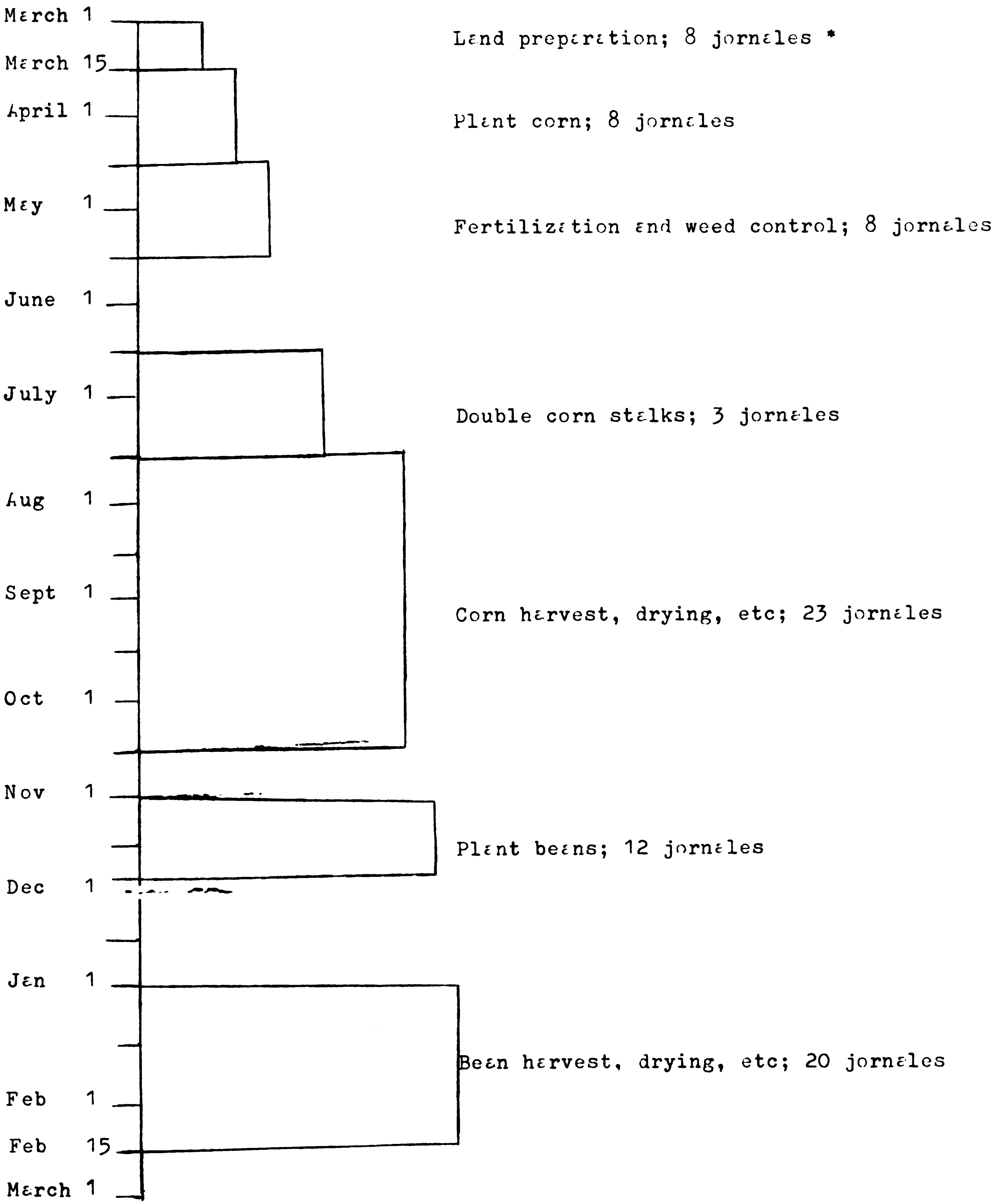
Most farmers are able to plant and harvest two crops a year on at least part of their land. The first planting takes place after the rains begin, between the 15th of March and the 15th of April. Normally, corn and/or rice will be planted, and it is also common for the farmer to plant 1/4 ha of beans for home consumption at this time. This is particularly true if the previous year's bean crop was poor. The first crop is harvested between July 15 and October 15, depending on the exact planting date, whether corn or rice is grown, and the cultural practices of the individual farmer. Most farmers with achiote will try to get their crops harvested before October 1st, because the achiote harvest begins in October.

October is also the month of the second corn planting. The second planting is located in a different field than the first planting. Thus while two plantings a year are realized in a corn-corn system, the system requires two hectares of land instead of one hectare as would be required for a corn-corn rotation in the same field. The second planting usually consists of corn being planted in October and/or beans planted in November.

Typical Systems

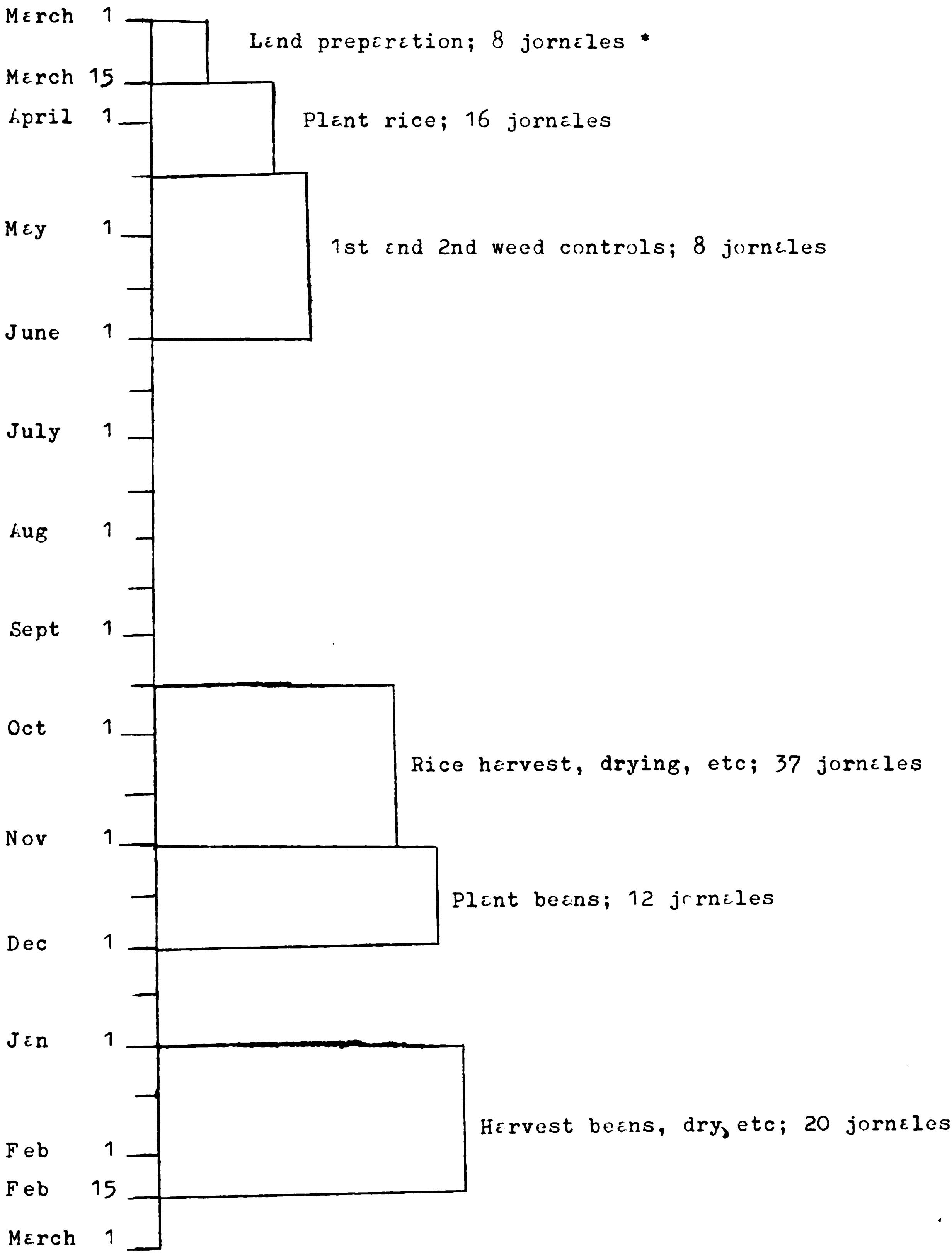
The typical basic grain cropping systems for the Quepos area are: corn-corn, corn-beans, rice-corn, rice-beans, corn in first planting, rice in first planting, and beans in second planting. When achiote is grown in any scale, this may limit the family's ability to get in a second crop, because harvesting the first crop, land preparation and planting of the second crop, and the achiote harvest all fall in the same period beginning about August 15th, -and running through October. If labor becomes a limiting factor, it will probably become limiting during the August 15-October 31 period. This can be seen from Figures 1-7 which show the time frame and jornales required for the various production activities carried out in the most common systems. These figures have been developed from information acquired at a meeting with small farmers from the Quepos area, and is representative of the production activities, the timing of production activities and the jornales required for each activity on a typical small farm. For additional information on timing of activities, materials used on each activity, and jornales required, see Appendix A. From Figures 1-7 one also sees that the period from February 1-April 15, could similarly become a tight labor period.

FIGURE 1.- Corn-bean labor requirements for one hectare of corn planted in March or April and another hectare of beans planted in Nov.



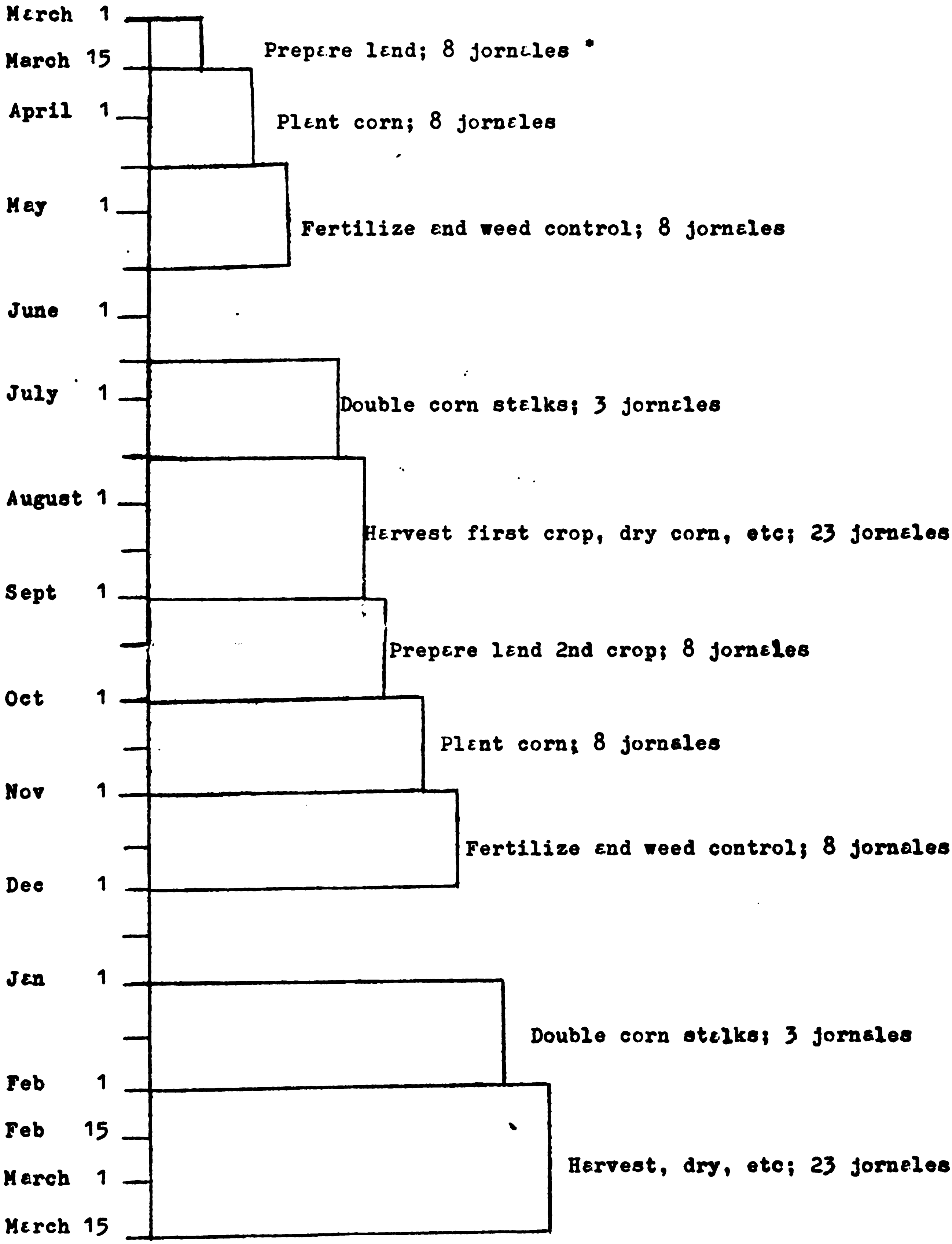
* a jornal in Quepos is 5 hrs of work, from 6 a.m.-11 a.m.

FIGURE 2 Rice-bean labor requirements for one hectare of rice planted in March-April and another hectare of beans planted in November.



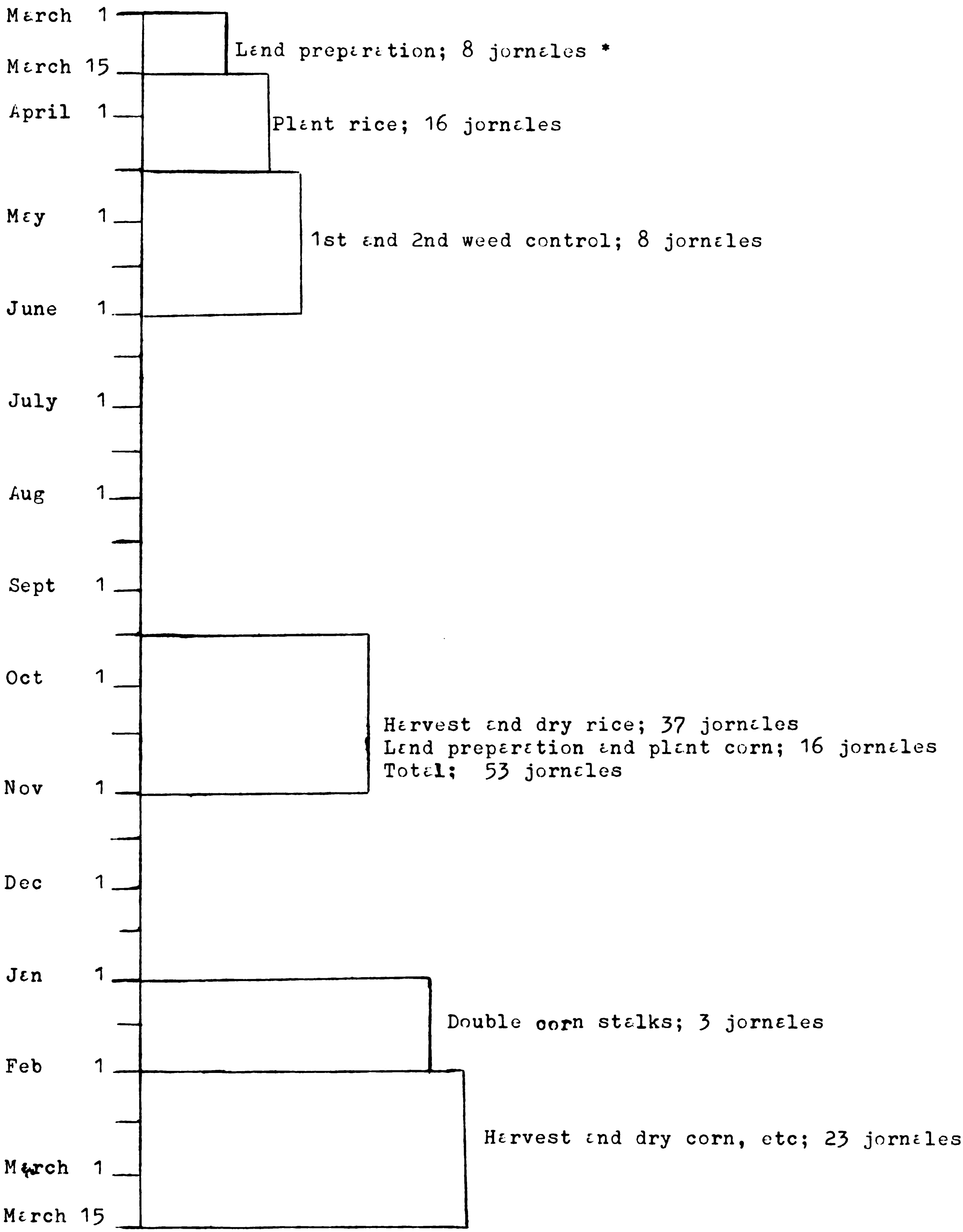
* A jornal in Quepos is five hours, from 6 a.m. to 11 a.m.

FIGURE 3 -Corn-corn labor requirements for one hectare of corn planted in March-April and another hectare of corn planted in October.



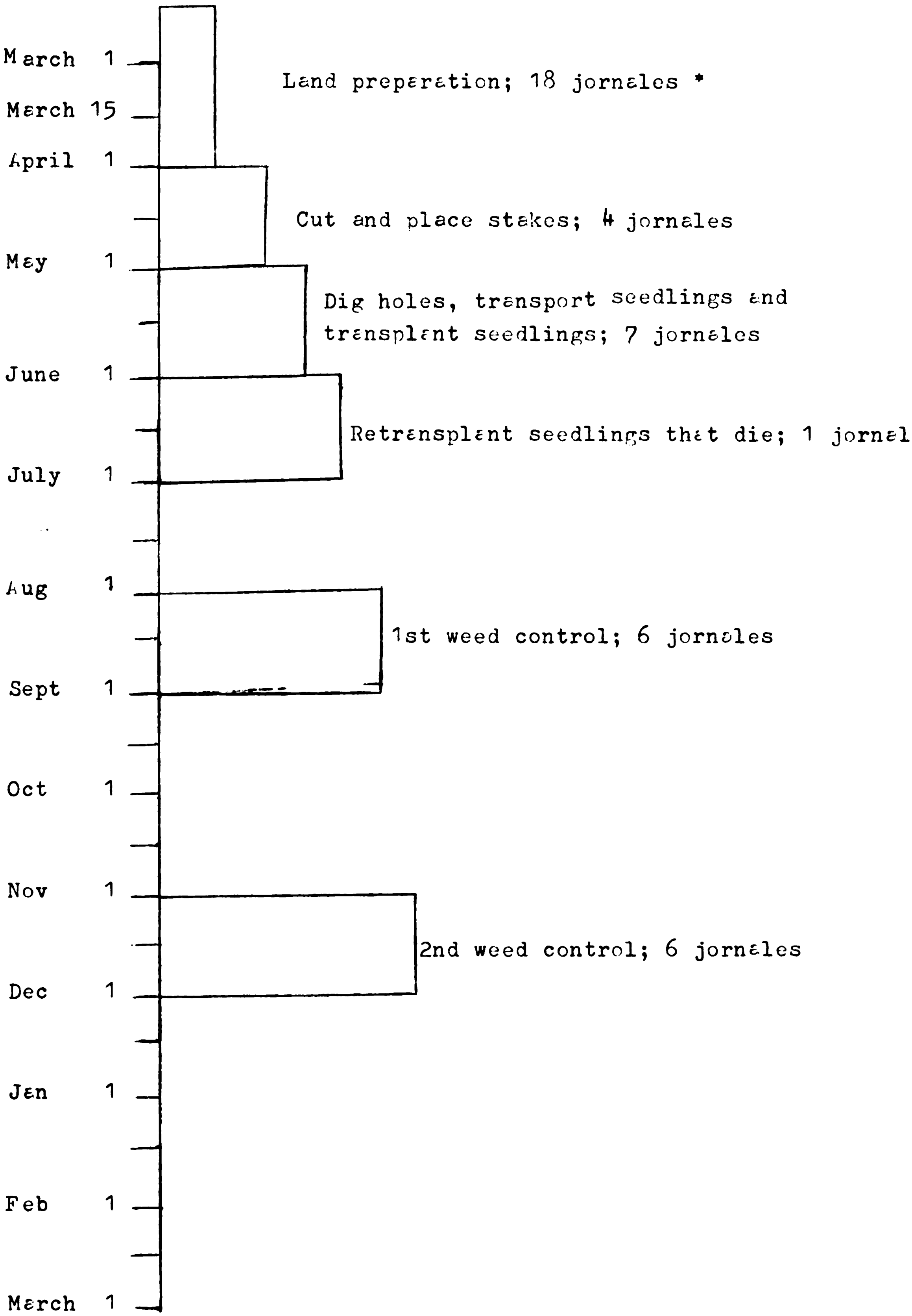
* A jornal in Quepos is five hours from 6 a.m. to 11 a.m.

FIGURE 4 Rice-corn labor requirements for one hectare of rice planted in March-April and another hectare of corn planted in October.



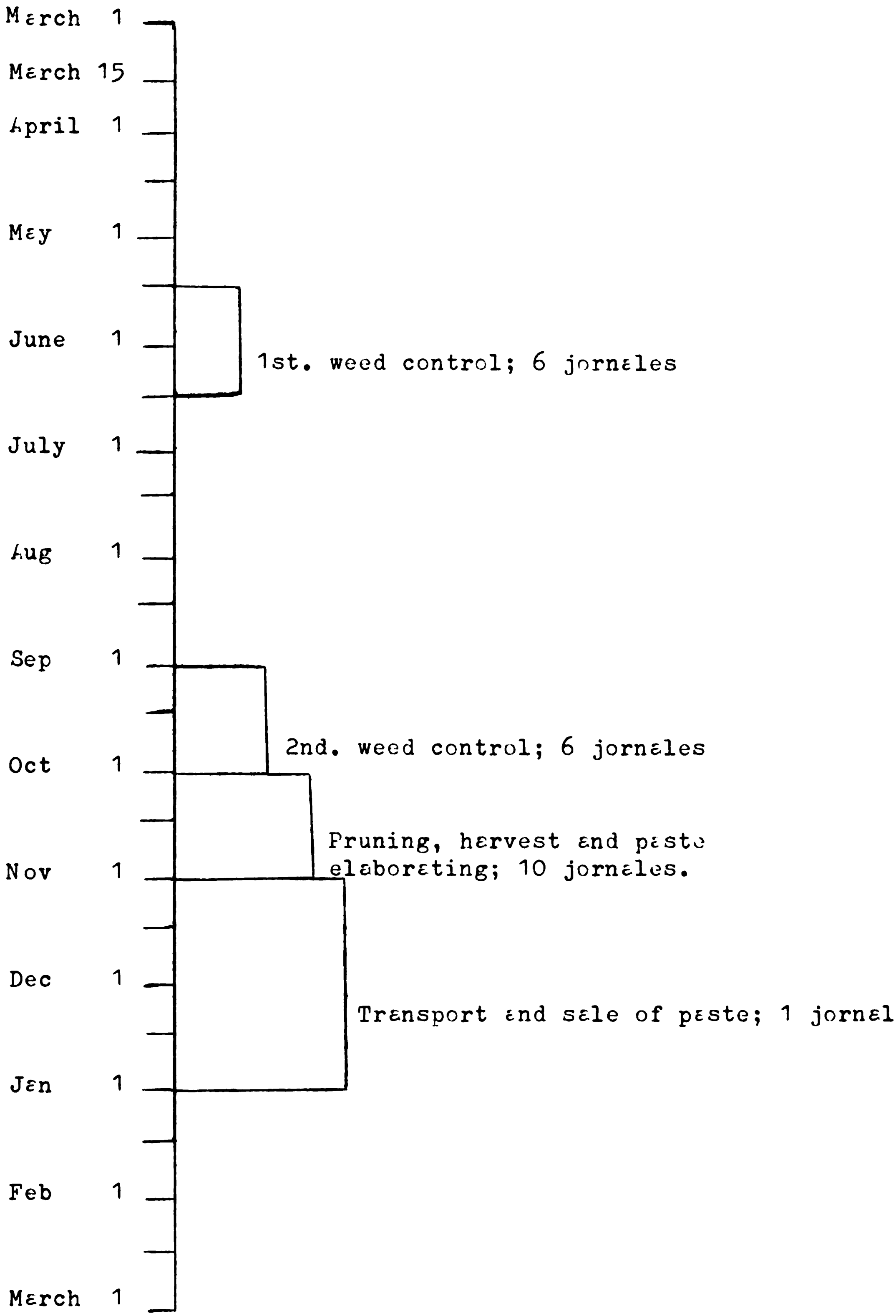
* A jornal in Quepos is five hours from 6 a.m. to 11 a.m.

FIGURE 5 First year labor requirements for traditional achiote on one hectare of land.



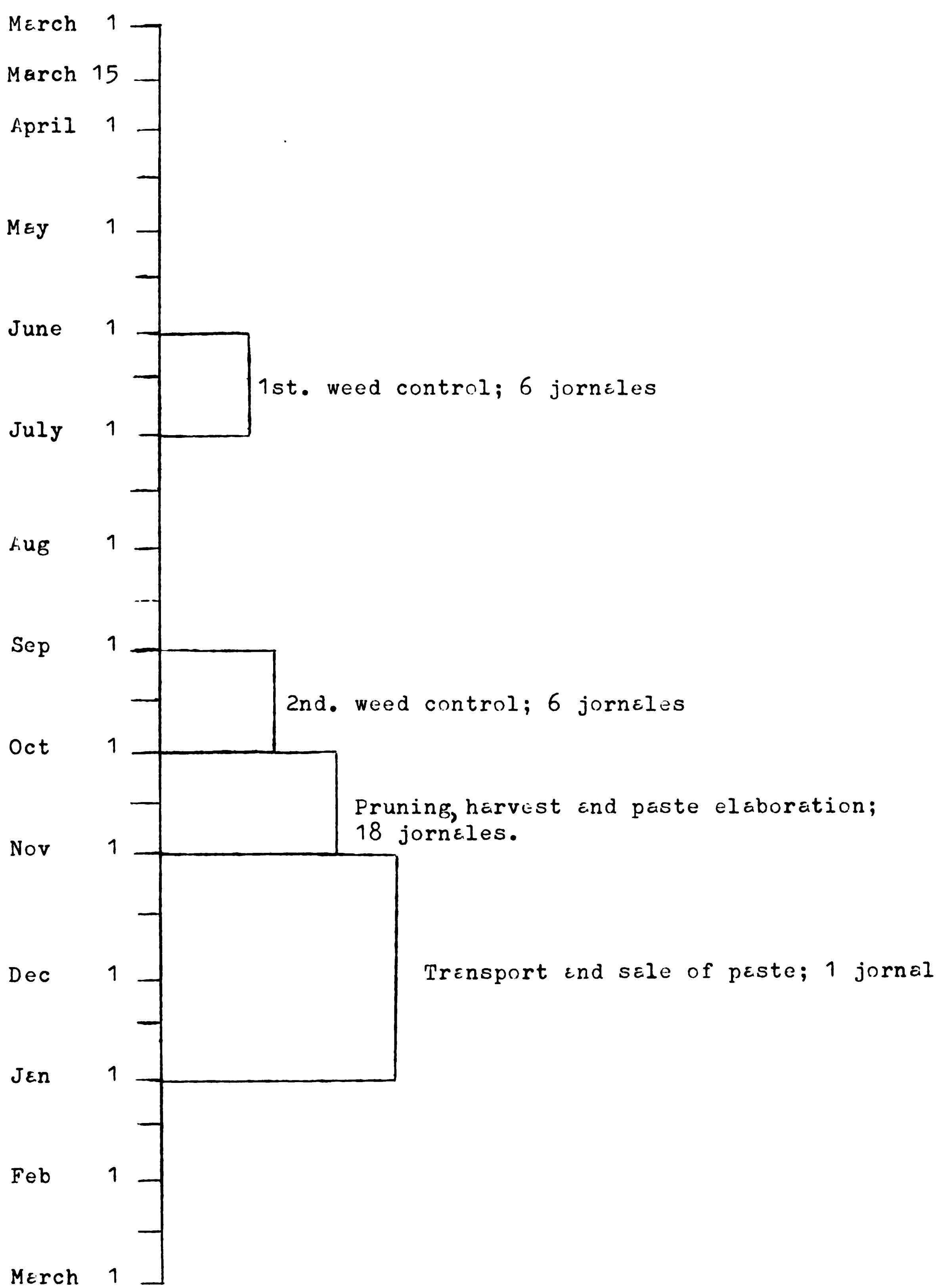
* A jornal in Quepos is **five** hours from 6 a.m. to 11 a.m.

FIGURE 6 Second year labor requirements for traditional Achiote on one hectare of land.



* A jornal in Quepos is five hours from 6 a.m. to 11 a.m.

FIGURE 7 Third year labor requirements for traditional Achiote on one hectare of land.



* A jornal in Quepos is five hours from 6 a.m. to 11 a.m.

Farm size and area cultivated:

In discussions with local farmers it was learned that farm size is quite variable; a typical farm size for the group we spoke with would be 10 ha. This is more land than the farmer can cultivate by hand, and hence, family labor is needed to fully utilize land resources. Mechanization is usually not possible because farms are located on steep slopes. Farmers indicated that the amount of land cultivated during each planting depended in part on the previous harvest. Normally the first planting would be between 2 and 4 hectares. If the yield was good, the second planting might be as little as one hectare. If the first harvest is poor, they try to recoup their loss by increasing land in cultivation for the second crop. It is interesting to note that families do not cultivate all the land they could. Instead, they grow enough to meet family consumption needs plus a little extra. This information suggests that small farmers near Quepos have accustomed themselves to a certain standard of living and try to maintain that standard by annually producing a given amount of basic grains. It seems that they do not try to increase their standard of living by producing additional amounts of basic grains. This may be caused, in part, by low $/hr returns from corn, rice, and until recently, bean production.

Family size:

Family size is fairly large among the farmers interviewed. Farmers indicated a typical family has 10-12 members. This corresponds with previous information regarding number of hectares cultivated, because an individual farmer needs assistance from his family if he plans to raise 3 or 4 hectares of annual crops during first planting. For purposes of discussion, one may assume a typical family is composed of ten members with the hypothetical age distribution shown in Table 1. Given the adult male equivalent coefficients shown in Table 1, the family has the equivalent of 20 adult male work hours per working day if we assume family members are able to devote eight hours a day to agricultural production. In terms of jornales, the family has 2.5 eight hour jornales or 4 five hours jornales which could be devoted to agricultural production each working day.

How much Achiote can the Typical Family Cultivate?

Achiote cultivation for a typical family of ten members with 10 hectares of land may be limited by both physical and psychological factors. Families explained that they wanted to raise at least as much corn, beans and rice as was needed for their own consumption. From Table 2, one sees that the family will consequently devote at least two ha to basic grains, which suggest that as much as eight ha could be devoted to achiote. Tables 3A and 3B however, show that harvest period labor requirements for achiote, permit the family to grow, at most, 4.44 ha of achiote because of a labor shortage in the period Oct 1 - Oct 31. This information conforms to farmer's estimates of their ability to increase achiote production. When asked how much achiote they felt a typical family could cultivate, they indicated that 3 ha of achiote would fit easily into their present cropping system. From Table 3B we also see that even though labor is limited in the Oct 1 - Oct 31 period, there is a good deal of excess labor during the rest of the year. Assuming that the farmer wishes to make maximum use of all his land and labor resources, he might adopt a system where he grows 6 ha of annual crops and 4 ha of traditional achiote. In Tables 4A and 4B one sees that such a system is feasible from a labor requirements view. This is probably the type of system a typical farmer would adopt if he had the land and family resources assumed here and if he were assured of a secure market and reasonable price for his achiote.

TABLE 1 Family labor supply for a "typical" farm family in Quepos

Family Members	Adult male equivalent coefficients	Members combined daily supply of adult male equivalent 8 hour jornales	Members combined daily supply of adult male equivalent 5 hour jornales
1 Husband	1.0	1.0	1.60
1 Wife	0.5	0.5	0.80
2 Children ages 10-14	0.3	0.6	0.96
2 Children ages 8-10	0.2	0.4	0.64
2 Children ages 4-8	0.0	0.0	0.00
2 Children ages 0-4	0.0	0.0	0.00
10		2.5	4.00

TABLE 2 **Typical family consumption of corn, beans and rice**

CROP	Amount required for own consumption (qq)	Yield qq	Number of ha required
CORN	20	30-40	0.67
BEANS	4	12-15	0.33
RICE	12-20	20	1.00
TOTAL			2.00

TABLE 3A Labor availability as a limiting factor for achiote production

Critical Periods	Activities carried out during this period	Hours devoted to 0.67 ha corn	Hours devoted to 0.33 ha beans	Hours devoted to/one ha rice	Total farmer equiv. hrs available for crop production*
March 1 to April 15	Land preparation and planting	54		120	700
July 15 to Sept. 30	Harvest and land preparation	77		185	1120
Oct. 1 to Oct. 31	Achiote harvest				400
Nov. 1 to Nov. 30	Bean planting		20		440
Jan. 1 to Feb. 28	Bean Harvest		33		820

* These figures assume the family will have only 100 working hours available per week because of rain, visits to town, household duties, care of animals, etc.

TABLE 3B. Labor Availability as a limiting factor for achiote production.

Critical Periods	Total Hours used on grains	Total hours available minus Hrs used on grains	Limiting number of achiote ha given achiote labor requirements
March 1 to April 15	174	526	
July 15 to Sept. 30	262	858	
Oct. 1 to Oct. 31	0	400	4.44
Nov. 1 to Nov. 30	20	420	
Jan. 1 to Feb. 28	33	787	

TABLE 4A. Labor availability on a typical 10 ha farm using the system:

Corn-corn, Corn-beans, Rice-beans (6 ha), plus 4 ha of mature traditional achiote.

Activities	Period when activities are completed	Hrs devoted to corn	Hrs devoted to beans	Hrs devoted to rice	Hrs devoted to achiote
Land Preparation	March 1-15	80		40	
Planting	March 15-April 15	80		80	
Fertilization and weed control	April 15-May 31	80		40	
Weed control and doubling of corn stalks	June 1-July 15	30			120
Harvest, land preparation and planting	July 15-Oct. 31	310		185	480
Planting and weed control	Nov. 1-30	40	120		20
Harvest and land preparation	Jan. 1-Feb. 28	130	200		

TABLE 4B. Labor availability on a typical 10 ha farm using the system:

Corn-corn, Corn-beans, Rice-beans (6ha), plus 4 ha of mature traditional achiote.

Activities	Period when activities are completed	Total Hrs devoted to crops	Total Farmer Hrs available *	Total farmer equivalent Hrs available *
Land preparation	March 1-15	120	90	220
Planting	March 15-April 15	160	190	480
Fertilization and weed control	April 15-May 31	120	255	640
Weed control and doubling of corn stalks	June 1-July 15	150	265	660
Harvest, land preparation and planting	July 15-Oct. 31	975	610	1520
Planting and weed control	Nov. 1-Nov. 30	180	175	440
Harvest & Land preparation	Jan. 1-Feb. 28	330	330	820

* These figures assume the farmer can devote 40 hours a week to crop production activities. Similarly, the family as a group is assumed to have 100 farmer equivalent hours which may be devoted to crop production activities.

Does traditional achiote production have sufficiently high ₡/ha and ₡/hr returns to make it worthwhile for farmers to increase achiote production?

In Tables 5 and 6, information on gross value of production per ha, net value of production per ha and net value of production per ha per hr of labor effort are presented. The prices used in Tables 5 and 6 are the prices which farmers expect to receive for these crops in a normal year. From this information it appears that achiote is a profitable crop for small farmers. It is particularly attractive when compared with corn or rice on a ₡/ha/hr basis. Achiote's ₡/ha/hr net value is twice as large as corn's and almost three times as large as the figure for rice. Beans are nearly as attractive as achiote, and a system featuring beans interplanted with achiote should be quite attractive. The net value/ha and net value/ha/hr figures for achiote in Tables 5 and 6 represent data from a mature achiote grove (one must keep in mind that the farmer earned nothing the first year). Second year (the first achiote harvest), net value/ha is approximately ₡1,695, and second year net value/ha/hr is ₡14.74. This is also an attractive figure when compared with corn and rice net value/ha/hr figures. From this information one may conclude that achiote does have attractive ₡/ha and ₡/hr returns and that it is worthwhile for farmers to increase their production, provided that prices remain at present levels.

Table 6 also points out that net value of production per ₡ invested in non-labor variable inputs is much higher for achiote than for the other crops (6.8 times higher than beans, 18.4 times higher than corn and 30.2 times higher than rice). Thus one sees that achiote makes very good use of the farmers scarciest resource, working capital, in addition to having favorable net returns per unit of labor and land.

TABLE 5. Gross and net value of production figures for small farmer crops

(1) Crop	(2) Yield (qq/ha)	(3) Price (₡/qq)	(4) Gross value of prod/ha (₡)	(5) Cost of Variable Inputs (₡/ha)	(6)-(4)-(5) Netvalue of prod/ha (₡/ha)
Corn	35.00	62.50	2187.50	204.25	1983.25
Rice	20.00	120.00	2400.00	346.80	2053.20
Beans	13.50	200.00	2700.00	100.00	2600.00
Achiote paste	1.50	1800.00	2700.00	15.00	2685.00
Achiote seed	19.03 [a]	141.88 [b]	2700.00	15.00	2685.00

(a) This yield figure is derived from the paste yield of 1.50 qq/ha using the conversion coefficient, 1 kilo of seed = 2.78 oz of paste. This coefficient is taken from Boletin Informativo Nº 8, Banco Nacional de Costa Rica, 1975, p. 26.

(b) This price figure is derived from the paste price of ₡18/lb on the assumption that the seed should be worth at least as much as the paste which can be made from it.

TABLE 6. Returns per ha and returns per hr for small farmer crops

(1) Crop	(2) Net value of prod/ha	(3) Total number of farmer hrs needed to produce crops	(4) Net value of prod/ha/hr of labor effort	(5) Net value of prod/$ spent on non-labor variable inputs
Corn	1983.25	250	7.93	9.71
Rice	2053.20	345	5.95	5.92
Beans	2600.00	160	16.25	26.00
Achiote paste or seed	2685.00	155 (a)	17.32	179.00

(a) These are the number or hours needed to maintain a mature achiote grove producing approximately 19qq of seed. Hours spent in establishing the grove are not counted here.

What are the prospects for selling achiote in export markets, and what price can the cooperative expect to receive from export sales?

When one mentions achiote to people who have worked in Central America for several years, one may encounter a faintly condescending attitude. This is due to the fact that experienced personnel, have heard newcomers become excited about achiote before, but this initial interest had not been transformed into successful production or export programs. There are two reasons for this. The first reason may be seen in Table 6 where it is pointed out that achiote's returns to invested land, labor, and capital on an hourly basis is only $17.32. This is not an unusually high return and since achiote is not easily mechanized it is difficult to increase this hourly return to labor through mechanization. Consequently, large farmers have not become interested in achiote. A second problem with achiote is that world prices have not been particularly favorable in the past. Add to this the influence of transportation costs on farm prices and the problem that a producer does not know the bixin content of his seed until after his grove is in production (and hence cannot be sure what his seed will be worth), and one begins to understand why achiote production has not been developed in the past.

Now, however, things appear to be changing. Achiote's labor requirements do not present problems for small farmers who find achiote an attractive crop compared with corn and rice. In addition, achiote's world market price has been rising in recent years. Table 7 presents information on achiote prices which, while useful, must be interpreted with care.

The reason for this is that achiote's price depends upon its bixin content which must be determined by laboratory analysis. In a letter to Travis King, Rural Development Officer of the USAID Mission to Costa Rica, R.L. Booth,

TABLE 7 Achiote price information

Source	Date or Period	Value of Seed (₡/qq)	Value of Seed ($/qq)
Farmers in Quepos estimate of market price in Quepos	Aug. 24, 1976	141.88	16.61
Richard Clark, President of Kalamazoo Spice Extraction Co. Kalamazoo, Michigan	June 19, 1976	115.29 FOB Limón	13.50 FOB Limón
R.L. Booth, Plant Manager Pfizer Inc., Milwaukee, Wisconsin	1970-74	256.20 2/ FOB Limón	30.00 FOB Limón
Ludwig Mueller Co. Inc. New York, N.Y.	Feb. 9, 1976	247.23 1/ FOB Limón	28.95 FOB Limón
R.L. Booth, Plant Manager Pfizer Inc., Milwaukee, Wisconsin	June 11, 1976	281.39 2/ FOB Limón	32.95 FOB Limón
Centro de Promoción de Importaciones y Exportaciones	Sept. 1, 1976	332.32 2/ FOB Limón	38.95 FOB Limón

1/ This price is based on a laboratory analysis of seeds sent to Ludwig Mueller by Mr. Byrd, the manager of the cooperative. This is the only price based on laboratory analysis.

2/ These prices are not based on laboratory analysis of the seed, and hence may be over estimates. There is a serious lack of information regarding Costa Rica seed quality.

the plant manager for Pfizer Inc. of Milwaukee, Wisconsin, states that last year Pfizer paid \$30/qq for Ecuadorian seed, \$37/qq for Peruvian seed and \$45/qq for Jamaican seed. Since these are FOB prices, part of their difference will be due to shipping costs and part will be due to bixin content (i.e., seed quality). Probably the most reliable price estimate in Table 7 is the one given by Ludwig Mueller which is based on laboratory analysis of seed sent to New York by Mr. Byrd, the cooperative manager. The actual price mentioned in Ludwig Mueller's letter to Mr. Byrd is "around" \$0.35 per lb CIF New York. This corresponds to the price in Table 7 of \$28.95/qq FOB Limon if the cooperative wanted to ship to New York. The cooperative would not, however, be likely to ship to New York because transportation arrangements and costs are more favorable when seed is shipped to Houston or New Orleans. In conversations with Jorge Chavez, Manager of R. Smyth and Company, Agentes de Aduana y Vapores, it was learned that shipment to Houston or New Orleans would cost approximately \$2.60/qq with sailings every eight days while shipment to New York costs approximately \$6.05/qq with sailings occurring only once a month. Consequently \$28.95/qq FOB Limon is a conservative estimate of the price the cooperative could receive.

In Table 8, information is presented on the likely costs of drying, packing and delivering 20 ton trailer loads of achiote to Limon FOB. In constructing Table 8 an attempt was made to obtain realistic cost estimates on the basis of very little hard data. These figures are based on telephone conversations with local businessmen and previous studies made for other crops. Consequently, costs cited here could differ from the costs revealed by a full scale feasibility study. From Table 8 one sees that the total of drying, packing and other charges required to convert

TABLE 8 Drying, packing, transportation and port costs estimates for shipment of dried achiote seed from Quepos to Limon FOB in 20 MT trailer loads.

ITEM	Cost per qq of seed (₡)	Cost per trailer load of seed (₡)
1. Dry seed preparatory to packing and shipment.	32.50 [(a)]	14,300.00
2. Packing materials		
a. Corrugated cardboard boxes with plastic liners to hold 50 lbs of seed.	8.60	3,784.00
b. Cotton bags with plastic liners to hold 100 lbs of seed.	5.00 [(b)]	2,200.00 [(b)]
3. Packing labor costs.	0.50	220.00
4. Transport from Quepos to San José to Limon	13.82	6,080.00
5. Pier service, policy of shipment, customs brokers fees, municipal duties and car movilization charges.	11.51	5,065.00
TOTAL	66.93	29,449.00

(a) Recently acquired information (Sept. 29, 1976) indicates that the cost of drying seed could be as low as ₡10/qq. As this is an unconfirmed estimate, the cost of ₡32.50 will continue to be used for calculations in this paper. The reader should, however, be aware that a cost reduction of ₡20/qq would result in an additional ₡50,680 sales revenue if the Cooperative were exporting their entire production (estimated at 2,534qq of dried seed). Such an increase in sales revenue would allow the Cooperative to increase its buying price for seed and paste.

(b) These numbers are not included in the totals since either cardboard boxes or cotton bags will be used, but not both. Since the cost of boxes is higher, it has been used in an attempt to avoid underestimation of costs.

achiote pods in Quepos to achiote seed in Limon FOB is approximately $66.93/qq. Using the Ludwig Mueller price estimate of $247.23/qq FOB Limon from Table 7, the cooperative would receive $180.30/qq for seed it exports. If the cooperative bought the seed from farmers for $141.88/qq (the seed price equivalent of the $18/lb paste price they now receive) this would represent a net gain to the cooperative of $38.42/qq that could be used to pay part of the cooperative overhead. This year, it is expected that the cooperative will purchase 200/qq of paste which is equivalent to 2,534/qq of seed. If these seeds were dried and sold at $247.23/qq FOB Limon, the cooperative would gross $97.356.28 from achiote sales on the export market.

If planting area and cooperative sales were doubled, cooperative gross value of sales could be increased and might even double. Thus it appears that even if the local markets were saturated and considerable amounts of achiote seed needed to be exported, this could be done at a price equivalent to the price farmers currently receive for their seed provided that export market prices do not decline.

Throughout this section, an attempt has been made to give realistic price and cost estimates and, at the same time, to avoid overestimating prices or underestimating costs. In other words, the figures presented here might be a little pessimistic. Two specific examples are the costs of drying and transporting seed (which might be lower than presented here), and the price the cooperative would receive for their seed (which might be as much as 25% higher than the price used here). At this point it is not particularly useful to speculate on how much farm prices could be raised or how much the cooperative might earn from more favorable cost and price figures for drying and transporting large quantities of achiote seed.

For the moment, one can only say that existing data indicates achiote could be shipped from Quepos to the United States without lowering current farm level prices and, hence, that export oriented production is possible.

<u>What Price Should the Cooperative Pay for Achiote Paste this Year?</u>

If the cooperative is to have an important impact on small farmer welfare it will eventually need to enter the export market. Costa Rica currently produces enough achiote for internal consumption, and additional plantings, capable of providing increased incomes for large numbers of rural families, will be dependent upon export market sales. Thus, even though the cooperative does not plan to export achiote this year, it would be advisable to set prices now which will facilitate eventual entrance into the export market.

<u>General Buying and Selling Price Considerations</u>

If an export market is developed, local achiote prices will probably adjust so that local prices will be at least equal to or possibly higher than export prices minus transportation, packing and port charges. Consequently, the cooperative will be able to pay more for local market achiote than for export market achiote. Although the cooperative will be selling exclusively on the local market this year, it would be wise to set an initial buying price low enough to allow the cooperative to compete in the export market. In this way the cooperative will avoid the problem of having to lower its buying price when it wishes to begin export activities. Setting a lower initial buying price would have the additional advantage of making it easier to raise investment capital and also provide the cooperative with a cash reserve that could provide insurance against problems caused by unforeseen future events. Of course, the cooperative does not have to build up a large cash reserve and may prefer to return (part or all) excess earnings to its members in the form of dividends based upon each member's sales volume. Declaring and paying dividends is usually not difficult to do when earnings are large, whereas voting to lower buying prices after a successful first year might be quite difficult. The cooperative will also have to exercise care in setting their buying price to ensure that the buying price is high enough to make achiote an attractive crop with earnings potential that will persuade farmers to increase production.

The cooperative's selling price should be at least as high as the export price for dried seed minus transportation, packaging and port charges to ensure that local market earnings per qq of seed produced are equivalent to export market earnings per qq of seed produced. If local market selling prices are presently lower than export market prices, the cooperative might want to consider raising local prices over a two or three year period to give local buyers and consumers a chance to adapt to the price increase. This strategy would also provide time for the cooperative to learn more about the value of Costa Rican seed on the world market and hence be in a stronger position when negotiating price increases with local buyers. In addition, the cooperative must be sure that the prices it decides upon provide a margin which will generate sufficient earnings to permit the cooperative to meet its loan repayment commitments and build up a small cash reserve.

In previous sections, we have seen that ₡141.88/qq of dried seed (or ₡18/lb of paste) is a buying price which provides farmers with incentive to increase production and also is low enough to allow exports of dried seeds. We also saw that if the cooperative were to export all of its production this year, a price of ₡141.88/qq of seed would result in earnings of ₡97,356.28. A recent INFOCOOP study of administrative, operating and interest costs shows that the cooperative will need ₡94,900 to meet its current loan commitment, and consequently a paste price of ₡18/lb might be a good buying price for the first year. If future information shows that export prices are higher than the ₡247.23/qq offer made by Ludwig Mueller (see Table 7), or if transporting, drying, and purchasing costs are lower, then buying prices could be increased. Another advantage of the ₡18/lb paste price is that farmers consider ₡18/lb to be a normal price. A serious obstacle to adoption of the ₡18/lb price is that the cooperative has already voted to establish this year's official buying price at ₡22/lb which appears to be too high to permit export sales of dried seed. The by-laws of the cooperative stipulate that 10% of the official price be withheld to pay for administrative and loan repayment expenses which means the agreed upon price of ₡22/lb would actually be reduced to a farmer price of ₡19.80/lb. This is also too high a price to permit the cooperative to meet its loan repayment schedule, if the entire first year production were to be exported given the assumptions made previously about export prices and costs. A buying price of ₡19.80/lb would result in export earnings of only ₡61,398.82 which is ₡33,501.18 less than the ₡94,900 needed for the first year's administrative, overhead, and loan repayment costs. Although the cooperative may be able to sell paste locally at a high enough price to overcome this deficit, it seems wiser to set the buying price at ₡18/lb and return any excess earnings to the farmers at the end of the season.

The Local Achiote Paste Market

At present, there exists a scarcity of reliable information concerning who will buy achiote from the cooperative, how much they will buy, and what these buyers are willing and able to pay. This lack of information makes it difficult to know what selling price the cooperative should establish this first year. Another difficulty in attempting to set a selling price is that achiote paste loses water through evaporation for the first six months after it is elaborated. So far, no one has come up with a simple but reliable way to test achiote paste's water content. Hence if the cooperative buys paste at ₡18/lb and sells it a few weeks or months later, some of the water will have evaporated and the cooperative will end up having paid ₡18/lb for water. The water weight loss from the time the paste is first hung in a bag to dry until it becomes quite dry and hard has been estimated at 50%. If the cooperative could wait until the paste has dried out to a hard brick-like form, it would be much easier to buy and sell paste at a fair price. Another problem in the paste has been that some farmers adulterate their paste with bananas, rock dust and other substances. The cooperative needs a means of testing for adulterants and at the same time, adjusting the paste price in accordance with the paste's water content. Sr. Ricardo Orozco, a local chemist, has said that he could devise simple tests to help solve these problems, and it would be advisable for the cooperative (or for INFOCOOP) to negotiate a contract with him (or some other person) as soon as possible, to try and resolve these problems before the achiote buying begins on October 11.

The Cooperative's Selling Price

In choosing a local sale price for achiote paste, one might begin by noting that the cooperative could receive ₡180.30/qq of dried seed, if the seed were exported at the Ludwig Mueller price. One qq of seed will make 8 lbs of paste and the paste should be worth at least as much as the seed, i.e., ₡180.30. This means the cooperative should sell dry paste for at least ₡22.54/lb.* Of course, some users of the paste can pay more than this.

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* If the cooperative's seed drying costs were reduced by ₡20/qq, this would increase dried seed export earnings by ₡20/qq and would raise the minimum sales price of dry paste to at least ₡25.04.

At present Mr. Byrd has received communication from four buyers. These are Aguilar and Solis, a chicken feed manufacturer, and three achiote paste factories which refine the paste and mix it with animal fats for household consumption. These paste factories are: Los Patitos, Fábrica Miguel Angel Rodríguez, and Fábrica Arturo Zúñiga. Of these four, only Aguilar and Solis has mentioned a price. Aguilar and Solis has tentatively agreed to purchase 25% of the cooperative's production (50 qq of very dry and hard paste) for ₡50/lb. If one assumes a water weight loss of 33% on paste which farmers sell to the cooperative, this wet paste is worth only ₡33.50 assuming that it can be resold in a very dry, hard state for ₡50/lb. Table 9 shows the relationship between water content and sales value based on a very dry and hard paste price of ₡50/lb. If one assumes that most of the paste brought to the cooperative will be 30% water, then the sales value of this paste is approximately ₡35/lb provided that it can be resold when dried out at ₡50/lb. In conversations with Olman Rodríguez and Neil Byrd, some achiote paste factories have said they sometimes pay as much as ₡30/lb for good paste. Consequently, the cooperative might be able to charge as much as ₡35/lb for paste with 30-33% water, if the paste is a good quality.

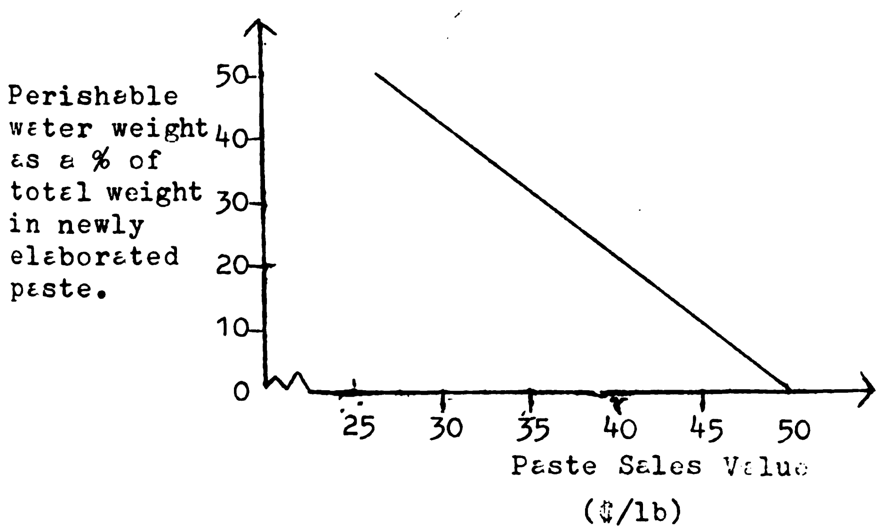
Unfortunately, the cooperative has no simple and reliable quality tests that could be used to rate paste from different sources. Consequently, it may be advisable to set a lower initial selling price until some kind of quality guarantee can be made.

Another consideration in setting a selling price is the amount of achiote being produced by non-cooperative members. If the cooperative sets too high a price for its paste, this will encourage achiote buyers to deal with other achiote producers. Since achiote grows wild in some parts of Costa Rica, this would encourage rural people to go achiote hunting, and it is difficult to estimate how much wild achiote might be elaborated into paste if the price were raised to ₡35/lb. In light of this uncertainty,

TABLE 9.- Value of paste with different water content based on a very dry paste price of ¢50/lb.

Perishable water weight as a percentage of total weight in newly elaborated paste	Sales Value (¢/lb)
0	50.00
5	47.50
10	45.00
15	42.50
20	40.00
25	37.50
30	35.00
35	32.50
40	30.00
45	27.50
50	25.00

Figure 8.- Relationship between sales value and water content.



it might be better to set a selling price which will be low enough to allow the cooperative to maintain control over the paste supply and, at the same time, help build up a good working relationship with achiote buyers. One suggested system for choosing a selling price for paste with 33% water is presented in Table 10, which shows several alternative sets of selling and buying prices. For each set, the cooperative's margin, earnings, costs, and profits (or cash reserve) are specified. From Table 10, one sees that a margin of approximately ₡4.75/lb is needed between selling and buying prices to meet first year costs (assuming no water loss and a sales volume of 20.000 lbs of paste). Thus, if the cooperative plans to pay farmers ₡19.80/lb, they must sell the paste (before water loss occurs) for at least ₡24.55/lb to meet operating and interest costs. Since there is usually a time lapse between the moment paste is bought and when it is sold, one must try to estimate the effect of water loss upon the minimum price the cooperative can accept. Figure 9 suggests a likely relationship between achiote paste's water, percentage and time. Figure 9 is derived from data supplied by Mr. Byrd and is admittedly only an approximation of the relationship between time and the paste's water content. Point A represents fresh paste which has just been hung up to dry. Half the weight of the bag will be lost over the next six months through evaporation. Point B represents the water content of paste which has been hung up to dry for one week. We assume that it will lose 33% of its original weight at point A by evaporation between point B and point D. Point C represents the water content of the paste when the cooperative begins to sell it. This will begin approximately one month after the paste has been elaborated and three weeks after the cooperative buys it. Point D represents paste which has dried for six months and will consequently suffer no further water loss. If the paste suffers an 18% weight loss due to evaporation, the price it is sold for will have to be 22% higher than the price it could have been sold for on the day it was bought, to provide the cooperative with the same total revenue. Earlier, it was pointed out that the cooperative must sell paste for at least ₡4.75/lb more than it buys paste for, to meet expenses. Thus paste which is bought for ₡19.80/lb would have to be sold for ₡24.55/lb assuming no water loss.

TABLE 10.- Possible basic price options for the achiote marketing cooperative.

Price paid to farmer for damp paste (¢/lb) (a)	Selling price for damp paste (¢/lb) (a)	Margin ¢/lb	First year earnings assuming a volume of 200qq (¢)	First year costs as estimated by INFOCOOP (¢)	First year cash reserve for invest or producer dividends (¢)
18	23	5	100.000	94.900	5.100
	27	9	180.000	94.900	85.100
	31	13	260.000	94.900	165.100
	35	17	340.000	94.900	245.100
19.80	23	3.20	64.000	94.900	- 30.900
	27	7.20	144.000	94.900	49.100
	31	11.20	224.000	94.900	129.100
	35	15.20	304.000	94.900	209.100
22	23	1	20.000	94.900	- 74.900
	27	5	100.000	94.900	5.100
	31	9	180.000	94.900	85.100
	35	13	260.000	94.900	165.100

(a) Damp paste is assured to be paste with approximately 33% water that has been elaborated and left to dry for one week. The 33% figure used here is a best approximation for the actual (unknown) water content of one week old paste.

With an 18% water loss, the paste would have to be sold for ₡29.94/lb. Similarly, paste bought for ₡19.80/lb and sold six months later, would have to be sold for ₡36.64/lb if the cooperative hopes to break-even.

Table 11 expands upon this idea by showing the minimum price the cooperative could sell paste for, at different points in time, given the assumed water weight losses shown in Figure 9. Table 11 speaks for itself regarding the minimum price the cooperative can afford to sell at, given the various purchase prices and assumed weight loss pattern. It is interesting to note that an 85% markup is needed just to break-even when paste is purchased at ₡19.80/lb and held six months. This is quite a high markup considering that the cooperative is assumed to have a sales volume of 200,000 lbs, and helps one understand why some intermediaries feel they need a markup of 100% or more just to breakeven given their smaller sales volumes. Table 11 also points out the danger in raising farm prices too high. A farmer price of ₡22/lb means the cooperative must resell this paste six months later at ₡39.92/lb. Whether or not the cooperative could induce all intermediaries to pay this high a price or whether the weight loss figures are as serious as assumed here is simply unknown. While it seems likely that Aguilar and Solis will live up to their commitment to pay ₡50/lb for 50/qq of dry hard paste, one doesn't know if the other intermediaries will be willing or able to pay this much. In an INFOCOOP preliminary estimate of the cooperative's ability to repay its loan, a selling price of ₡30/lb is assumed. Given the levels of past prices, the cooperative's imperfect control over supply, the problem of potential competition, and the cooperative's inability to provide quality guarantees, this seems a reasonable level for the selling price of paste with a water content of 15%. From Table 11, one sees that this selling price rules out the possibility of paying farmers ₡22/lb and that a buying price of ₡19.80/lb is just barely high enough to meet estimated first year costs. Again, considering the uncertainty involved, it might be better to pay farmers ₡18/lb because this price would provide the cooperative with a cash reserve of ₡45,200. Then if there are no unforeseen

Figure 9. Water weight losses over time for achiote paste.

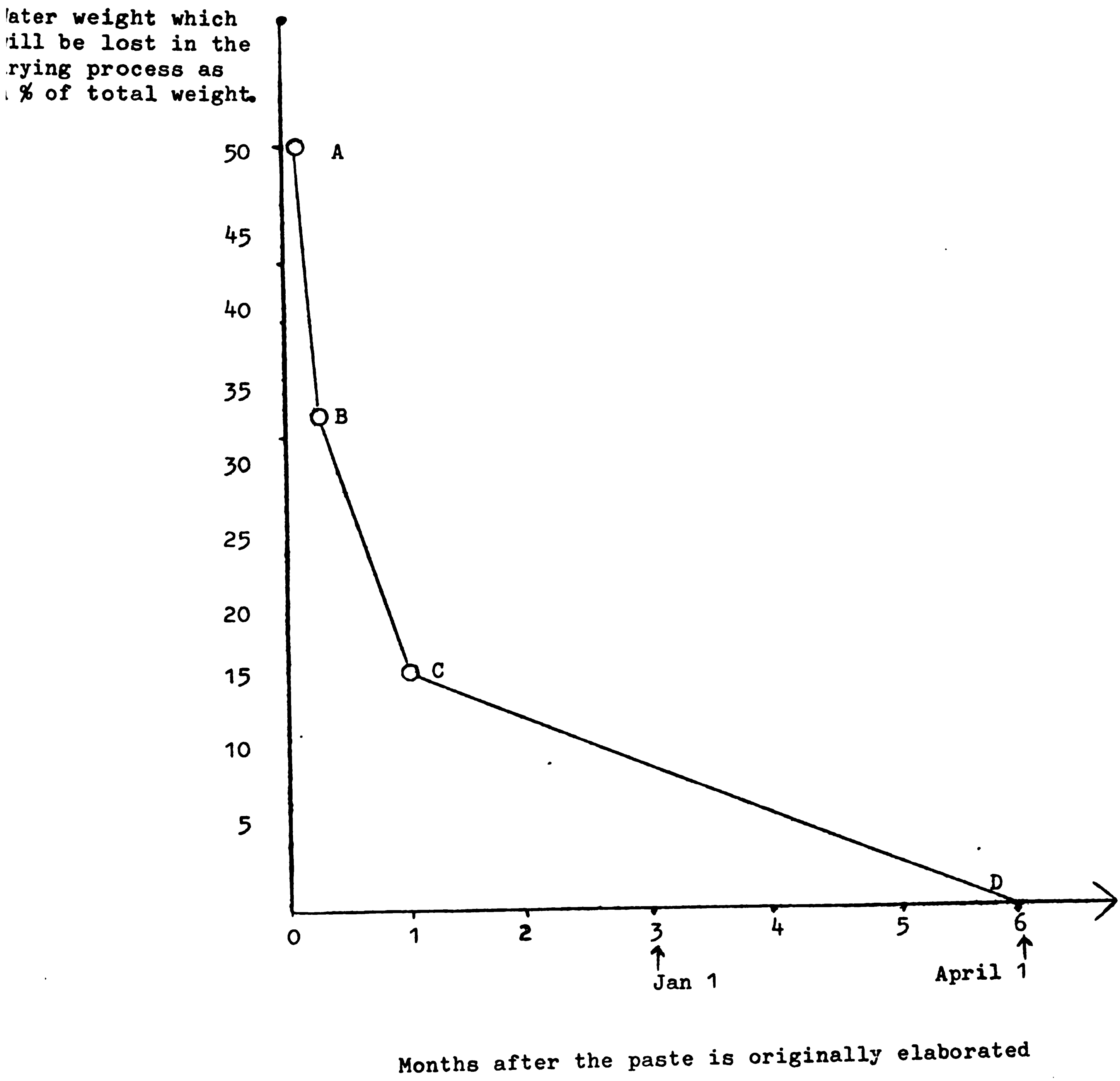


TABLE 11.- Minimum break-even achiote paste prices

Price paid to farmer for damp (33% water) paste (¢/lb)	Water weight % when paste is sold	Time paste is dried	Break-even selling price (a) (¢/lb)
18.00	33	1 week	22.75
	15	1 month	27.74
	0	6 months	33.96
19.80	33	1 week	24.55
	15	1 month	29.94
	0	6 months	36.64
22.00	33	1 week	26.75
	15	1 month	32.62
	0	6 months	39.92

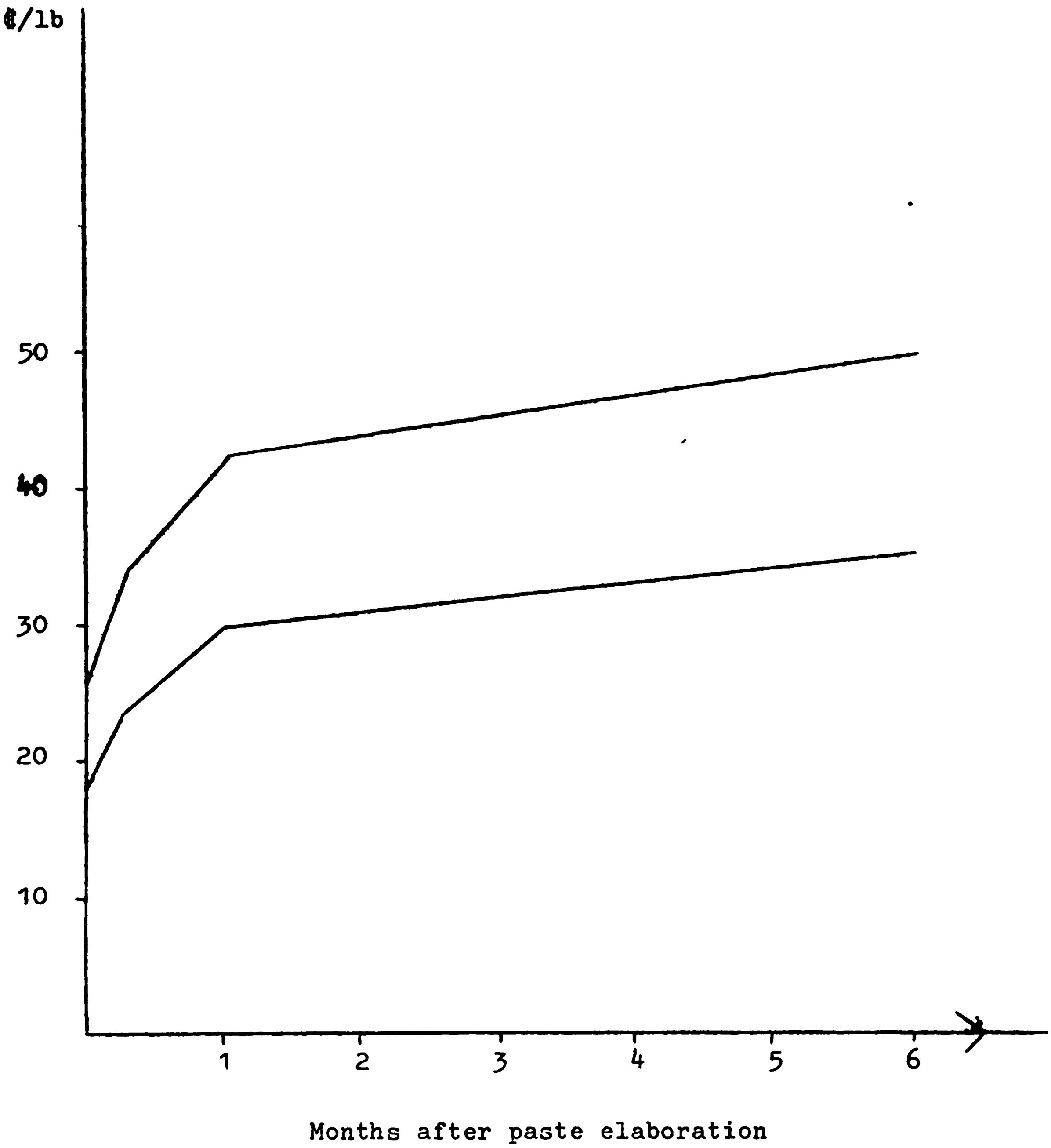
(a) This assumes a sales volume of 20,000 lbs the first year.

expenses, part or all of this money could be returned to farmers at the end of the season. This seems like a prudent course of action because it: (1) provides farmers with an immediate payment for their achiote which is greater than they are currently earning from corn, rice, and beans, (2) sets a buying price which should enable dried seed exports next year, and (3) provides the cooperative with a small cash reserve even though the selling price assumed (₡30/lb for paste with 15% water) should be a conservative estimate of the price buyers will be willing and able to pay.

This section points out the need for some kind of price commitment from achiote buyers before the cooperative begins its achiote purchases. If the cooperative can persuade buyers to accept the ₡50/lb price paid by Aguilar and Solis for very dry achiote, then a buying price of ₡22/lb or ₡19.80/lb should be all right. If, on the other hand, buyers are willing to pay only ₡30/lb for paste with 15% water weight (equivalent to a very dry, hard paste price of ₡35.29/lb) then a cooperative buying price of ₡18/lb appears necessary.

The relationship between perishable water weight as a percentage of total weight, the rate at which water weight is lost through evaporation and paste value, has been summarized in Figure 10. Figure 10 shows the price which paste should be sold at, to provide constant sales revenue while water is lost through evaporation. The top line shows the value of paste at different points in time when the standard price is ₡50/lb for very dry paste. The bottom line shows the value of paste at different points in time when the standard price is ₡30/lb for paste with 15% perishable water weight (as a percentage of total weight

Figure 10. Equivalent selling prices for paste with different water content at different points in time.



when the paste was first hung up to dry). When the cooperative decides what their standard selling price will be and what type of weight loss by evaporation pattern actually holds, a figure similar to Figure 10 can be drawn up to aid cooperative members in setting selling prices for paste at different points in time.

Given that achiote paste purchases by consumers represent a very small portion of their total purchases, achiote paste mixers and packers could probably raise their prices quite a bit to cover increased raw materials costs. Thus it may be possible to bring all achiote paste buyers up to the ¢50/lb price set by Aguilar and Solis. It is also possible that achiote paste is worth more to concentrated chicken feed manufacturers than to other buyers. Several chicken feed manufacturers should be contacted to see if this is true, and if they would be interested in buying dry achiote paste for ¢50/lb. Until this is done, however, the cooperative should consider paying farmers only ¢18/lb for their paste.

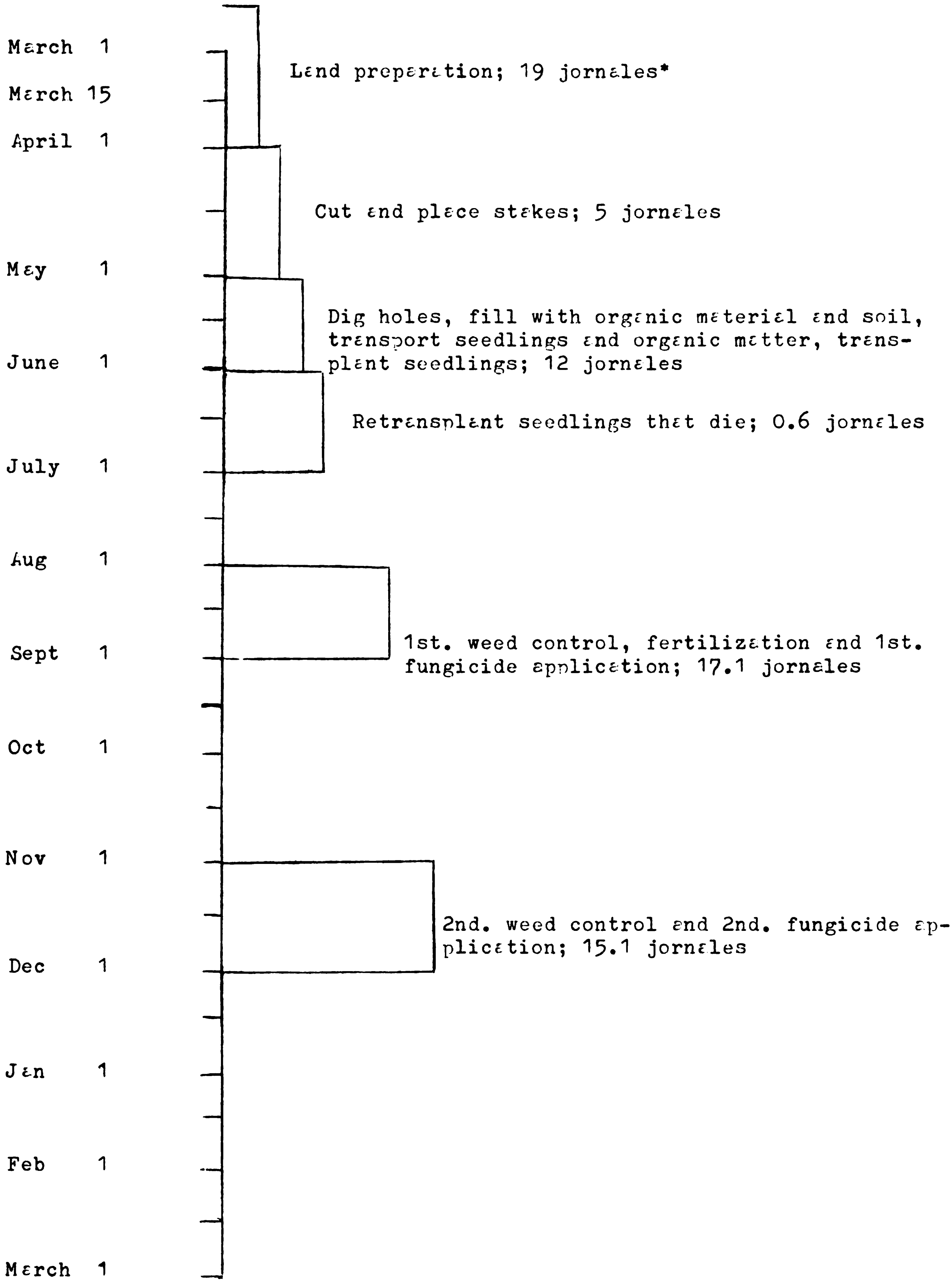
<u>If Achiote Were Produced in a Technified Manner, What Effect Would This Have on Yields and Farm Incomes</u>

At present, there is very little information on technified achiote production in Costa Rica. The term technified achiote production is used here to mean a more capital, chemical, and labor intensive achiote production which may be contrasted with the traditional achiote production information presented earlier. The only known source of technified achiote production information currently available is a study first published in 1969, by the Oficina del Café (Estudio Sobre El Achiote by Carlos L. Lizano P.), and adapted by the Banco Nacional de Costa Rica in 1975 ("El Cultivo del Achiote," Boletin Informativo Nº 8, 21 p.). This source was used as the basis for construction of Appendix Tables A8, A9, and A10 which contain the intensive achiote production data used here. Figures 11, 12, and 13, showing the yearly distribution of labor requirements for intensive achiote production have been constructed from Tables A8, A9, and A10.

Intensive vs. Traditional Achiote Yields

Table 12 presents information on achiote yields from various countries and shows that reported yields vary considerably between countries. This is due to differences in climate, varieties, and cultural practices which cause variation in yields of dried seeds/tree and in numbers of trees/ha. The Quepos area yield of 19.03 qq of dry seed is near the bottom of the yield/ha group in Table 12, even though the Quepos ecological system should be quite good for achiote and the number of trees/ha for Quepos area production is relatively large. Given the information in Table 12, it appears that Quepos area achiote yields could be raised considerably. Although there is very little basis for a prediction of future yields, it would not be surprising if dried seed yields were raised to 33 qq/ha (paste yields would be raised to approximately 2.64 qq/ha), by adoption of the improved cultural practices suggested in Appendix Tables A8, A9, and A10. With an improved selection

FIGURE 11 First year labor requirements for intensive achiote production on one hectare of land.



* A journal in Quepos is 5 hours from 6 a.m. to 11 a.m. Labor requirements are based upon data presented by the Sección de Planificación de Proyec-

FIGURE 12 Second year labor requirements for intensive achiote production on one hectare of land.

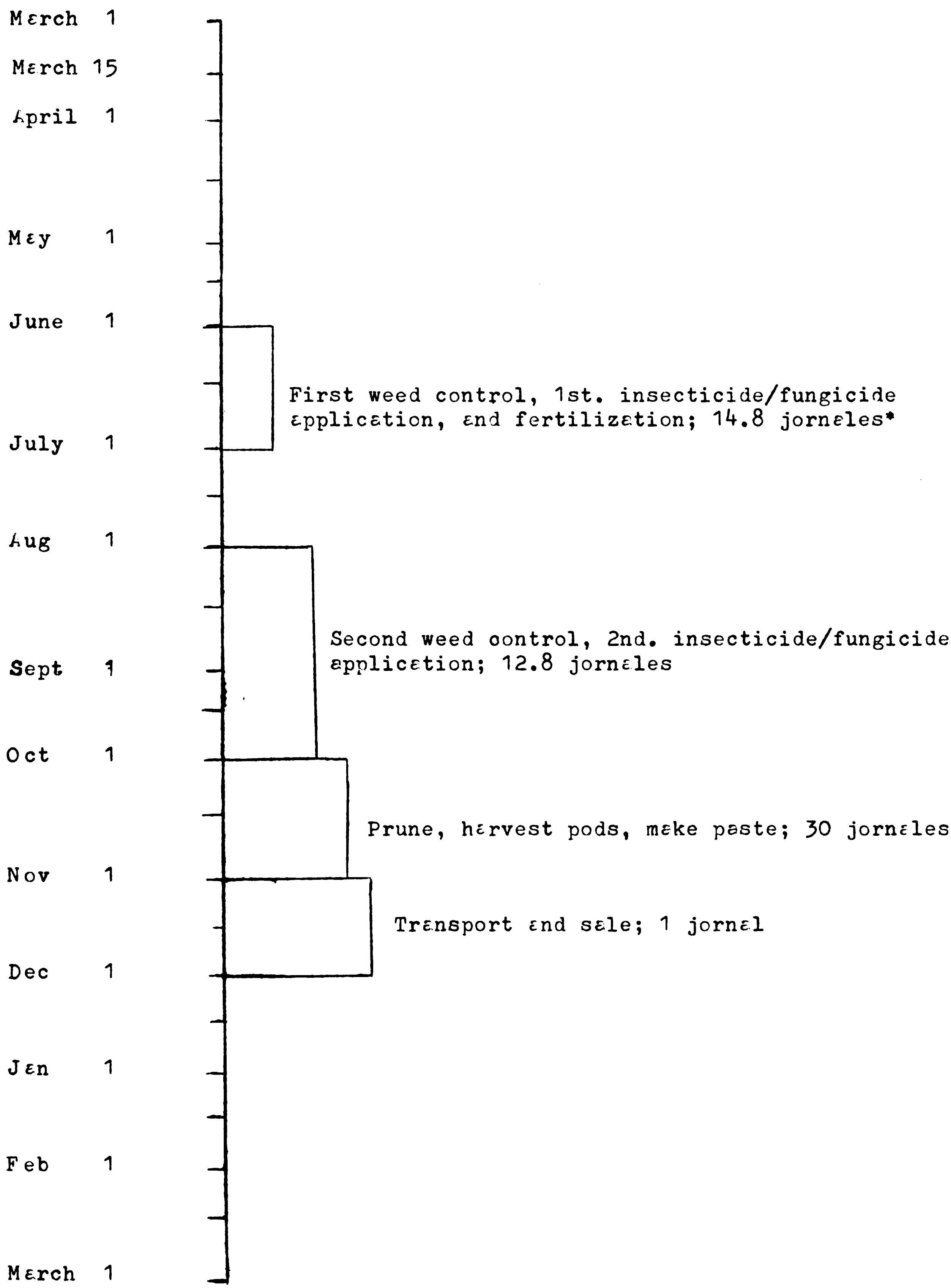
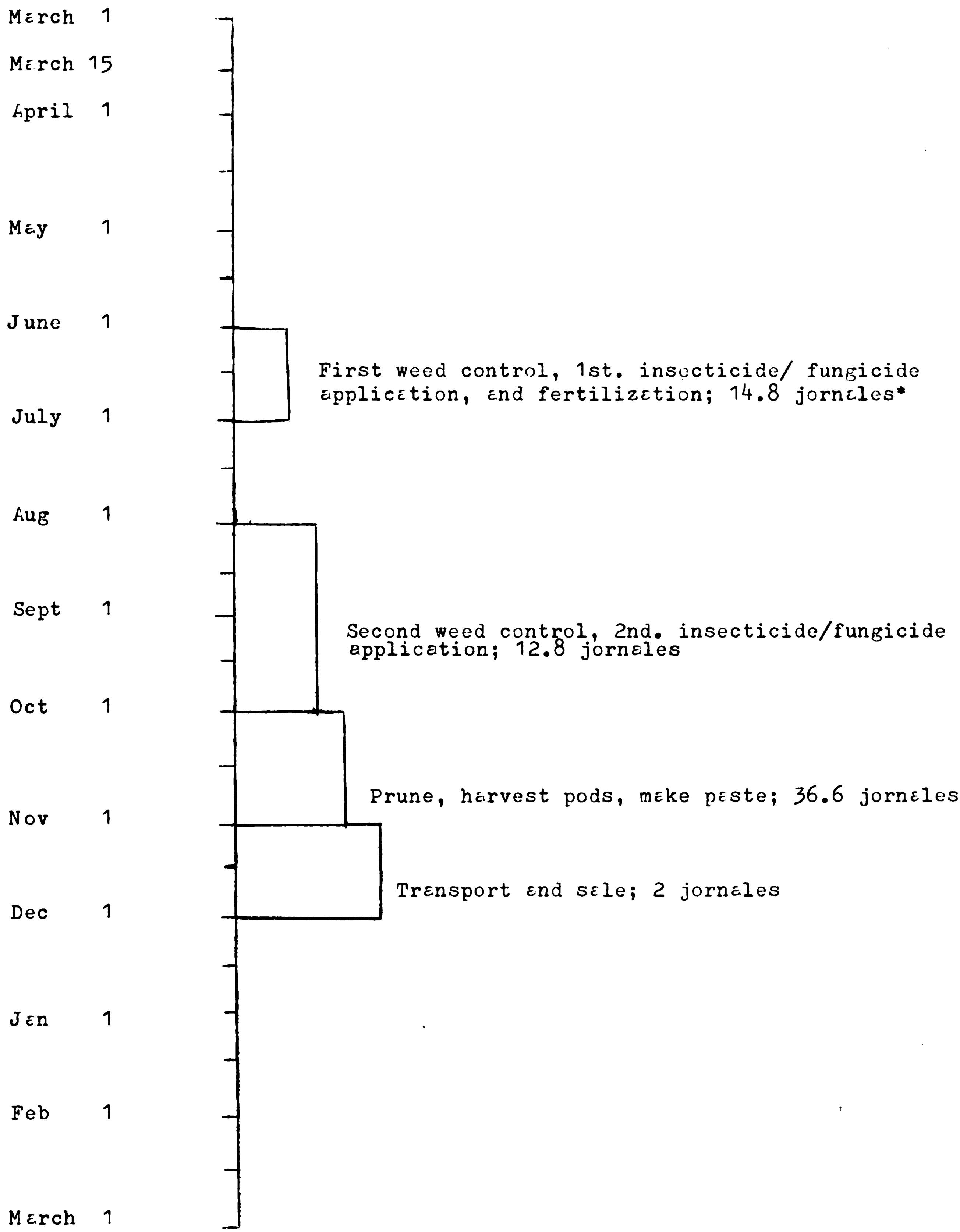


FIGURE 13 Third year labor requirements for intensive achiote production on one hectare of land.



* A jornal near Quepos is 5 hrs -- from 6 a.m. to 11 a.m.

TABLE 12 Traditional vs. intensive achiote yields.

Country	Source	Yield, lbs of dried seeds per tree	Yield, qq of dried seeds per hectare	Yield, qq of paste/hectare (a)	Number of trees per hectare, either given or assumed
Costa Rica	Farmers near Quepos	2.29	19.03	1.50	830
International average with various numbers of trees per hectare	Ingram (b)	--	7.70 - 15.40	0.46 - 1.23	--
Kenya	Ingram (b)	--	11.00 - 22.00	0.66 - 1.76	--
India	Ingram (b)	--	13.20	0.79 - 1.05	--
Indonesia	Ingram (b)	2.2 - 6.38	15.40 - 44.66	0.92 - 3.57	700 (assumed)
Central American farmers	Pfizer (c)	2.5 - 3.0	30.09 - 36.11	1.80 - 2.89	760
Argentina	Lizano (d)	--	33.00 (average)	1.98	494 - 816
Peru	Lizano (d)	--	33.00 - 44.00	1.98 - 3.52	--

(TABLE 12 continued in next page)

TABLE 12 (continued). Traditional vs. intensive achiote yields.

Country	Source	Yield, lbs of dried seeds per tree	Yield, qq of dried seeds per hectare	Yield, qq of paste per hectare (a)	Number of trees per hectare, either assumed or given
Colombia	Lizano (d)	---	33.00 - 44.00	1.98 - 3.52	----
Colombia	Ingram (b)	---	44.00	2.64 - 3.52	----
Central American experiment stations	Pfizer (c)	4.5 - 5.8	54.17 - 69.82	3.25 - 5.58	760
International average based on obtainable lbs/tree	Ingram (b) (e)	9.9 - 11.0	69.3 - 77.00	4.15 - 6.16	700 (assumed)
Unnamed	Kalsec (f)	9.0	88.90	5.33 - 7.11	988

(a) Where sources do not specify the relationship between lbs of dried seed and lbs of paste, the lower dried seed/ha figure is multiplied by 0.06 to get the lower paste/ha figure. Similarly the upper dried seed/ha figure is multiplied by 0.08.

(b) Ingram, Jean S. and Francis B. J., Tropical Science, Volume XI, Number 2, "The Anatto Tree (*Bixa orellana* L)-A Guide to its Occurrence, Cultivation, Preparation, and Uses," pp. 97-102.

(c) This information is contained in a letter which R. L. Booth, Plant Manager of Pfizer Inc.'s Milwaukee Operations sent to Mr. Travis King, Rural Development Officer, USAID Mission, San José, Costa Rica.

(d) Lizano P., Carlos L., Estudio Sobre El Achiote, Oficina del Café, Marzo 1969.

(e) This international average based on obtainable lbs/tree assumes more than one harvest per year. Such a yield pattern may not be obtainable in Costa Rica.

(f) This information is found in Lizano's paper, p. 30. It is based upon information which Kalsec (Kalamazoo Spice Extraction Company of Kalamazoo, Michigan, USA) sent to the Ministry of Agriculture in 1967. These yield data are based upon successful adoption of some Ecuadorian varieties which Kalsec knows of.

of local varieties or introduction of new varieties, yields might be raised even higher.

The data provided by R. L. Booth of Pfizer, Inc. suggests that 33qq of dried seed per ha (2.64 qq of paste) is an attainable target yield for small farmers in the Quepos area. To see what this yield figure means in terms of farm incomes, one may compare a typical farmer's income and labor utilization pattern on: a corn, bean and rice farm; a corn, bean, rice and typical achiote farm; and a corn, bean, rice and intensive achiote farm.

Income and Employment on a Quepos Area Corn, Bean and Rice Farm

In an earlier discussion of farm size and area cultivated (p. 11) it was pointed out that families do not cultivate as much land as their family labor supply indicates they could. During a group interview last August, farmers indicated they normally plant 2-4 ha of corn and rice in April and 1-3 hectares of corn and/or beans in October and November. Thus the maximum amount of land the typical family cultivates appears to be 7 ha. It was suggested that one explanation for this underutilization of land might be the relatively low returns the farmer earns per hour of labor effort from corn and rice production--with such a low return, the family prefers leisure to increased income. Another factor may be the difficulty of planting more than 3 ha of beans during November given the normally high amount of rainfall at this time of year.

Examination of the timing of production activities and labor requirements presented in Figures 1 and 2 for corn-bean and rice-bean systems shows that the family probably could raise 10 ha of corn, beans, and rice if they adopted the cropping system: one ha of rice and 4 ha of corn planted in March or

April followed by 5 ha of beans planted in November (weather permitting--they may have to plant in the rain some years). Table 13 shows that this is a feasible cropping system from a labor supply--labor requirements point of view. The net value of production from such a system using the prices given in Table 5 is ₡22,986.20. This is an attainable figure for net value of production if the family can plant five ha of beans during November. Should the family plant only 3 ha of beans, net value of production would be reduced to ₡17,786.20. Total farmer equivalent labor hours required for the farming system in Table 13, is 2145. This represents approximately 54% of the family's available labor supply assuming family members would like to devote 40 hrs/week to crop production. If the family is only able to plant 3 ha of beans, total labor requirements will be only 1825 hours or 46% of the family's labor supply. Net value of production per hour for these farming systems is ₡10.72 if five ha of beans are grown and ₡9.74 if only three ha of beans are grown.

<u>Income and Employment on a Quepos Area Corn, Bean, Rice and Traditional Achiote Farm</u>

Table 4B on p. 18 demonstrates that a farming system composed of the cropping systems: corn-corn; corn-beans; rice-beans and 4 ha of mature traditional achiote is feasible from a labor requirements view. Using the prices presented in Table 5, net value of production from this farming system is ₡23,942.95. The system makes use of 2035 farmer equivalent hours which is approximately 51% of the total family labor supply. Net value of production per hour is ₡11.76. Given the relatively high current price of beans, a farmer might wish to change this farming system to the following one: corn-beans, corn-beans, rice-beans, 4 ha of mature achiote, which has a net value of production equal to ₡24,559.70 and uses 1945 of the family's farmer

TABLE 13 Labor availability on a typical farm using the systems: rice-beans on 2 ha and corn-beans on 8 ha.

Activities	Period when activities are completed	Approximate family supply of farmer equivalent hours (a)	Hours required for crops
Land preparation	March 1-March 15	160-200	200
Planting	March 15-April 15	320-400	240
Fertilization and weed control	April 15-May 31	480-600	200
Weed control and doubling of corn stalks	June 15-July 15	320-400	60
Harvest, land preparation and planting	July 15-Oct. 31	1120-1400	645
Planting	Nov. 1-Nov. 30	320-400	300
Harvest	Jan. 1-Feb. 15	480-600	500

(a) The range given here is based on two alternate assumptions regarding work hours per week. The lower figure assumes that 32 hrs/family member/week may be devoted to crops while the upper figure assumes that 40 hrs/family member/week (given each family member's adult male equivalent coefficient) may be devoted to crops each week.

equivalent hours (approximately 49%). Net value of production per hour in this modified system is ₡12.63.

Income and Employment on a Quepos Area Corn, Bean and Intensive Achiote Farm

Intensive achiote requires almost twice as much labor at harvest time as traditional achiote. Consequently, the typical family would need to limit intensive achiote production to approximately two hectares. Net value of production figures per hectare and per hour of labor effort, for traditional and intensive achiote production are contrasted in Tables 14A and 14B.

In Table 14B one sees that an intensive achiote yield of 33 qq/ha increases net value of production per ha by 56%, but lowers the farmer's returns per hr by 26%. If intensive achiote yields were 44 qq per ha and labor requirements remained the same, hourly returns from traditional and intensive achiote production would be about the same. Forty-four qq of dried seed may be an attainable yield in Costa Rica, but whether or not labor requirements would be constant is unknown. It should also be pointed out that since existing data on technical achiote labor requirements in Costa Rica is non-existent, the 331 hours per ha suggested in Table 14B should be regarded as an estimate which may need to be revised later.

If the family raises two hectares of intensive achiote, they could devote eight hectares to the corn-bean system first presented in Figure 1. Analysis of Figure 1 and 13 shows that this would be a feasible farming system from a labor requirements viewpoint. This system would have a total net value of production equal to ₡26,712.68 and would use 58% of the family's total labor supply (2302 hrs). Returns per hour of labor effort would be ₡11.60. If November rains make it difficult to plant four hectares of beans, the system could be altered by adding one more hectare of corn in first planting and one less hectare of beans in second planting. This alteration would result

TABLE 14-A Gross and net value of production figures for [illegible]

Type of Production	Price of dried seed (₡/qq)	Yield of dried seed (qq/ha)	Gross Value of Prod. per ha	Costs of Chemical inputs per ha	Net Value of production per ha
Traditional	141.89 [(a)]	19.03	2700.00	15.00	2685.00
Intensive	141.89 [(a)]	33.00	4682.04	492.20	4189.84

TABLE 14-B Net value of production per hectare and per hour of labor effort for traditional and intensive achiote production

Type of Production	Price of dried seed (₡/qq)	Net value of production per hectare	Hours of labor required per hectare	Net value of production per hectare per hour
Traditional	141.89 [(a)]	2685.00	155	17.32
Intensive	141.89 [(a)]	4189.84	331 [(b)]	12.66

(a) This dried seed price is equivalent to a paste price of ₡18/qq (paste with 33% water). It was shown earlier that seed could be exported at this price. It was also shown that farmer prices for achiote could be higher than this figure; ₡141.89/qq is a conservative estimate of the farmer's selling price, hence these are conservative estimates for gross & net value of production per ha and per hour.

(b) It was pointed out to me that this figure may be high. The hours required for each production activity are given in Appendix Tables A-8, A-9, A-10. This information was supplied by the Technical Assistance Dept. of the Banco Nacional de Costa Rica. I believe this data is a good approximation for intensive achiote production, but one must keep in mind that it is not based upon achiote production observations on experiments conducted in Costa Rica. One figure which has been questioned is the 12.8 Jornales (64 hours) required for weed control (chapia) and insecticide/fungicide applications (see Tables A-9, A-10) during the second, third and subsequent years. The original data prepared by the Banco Nacional de Costa Rica specifies that a "chapia" or weed control is done twice a year and requires 95 hours (47.5 hours each time). This seems high, but it is also likely that weed control will have to be done more than twice a year. Data from Guatemala on apple production suggests that the "limpia o chapia" may be done chemically and will require no more than 16 hrs/ha; but it will be done 5 times/yr (or 80 hrs/yr). Either or neither of these figures may be correct and one does not know what figure should be used for hrs of labor required/ha. Consequently, the lower ₡/ha/hr figure for intensive achiote production in this table should be regarded simply as a first estimate which may need to be revised when more data becomes available.

TABLE 15 A comparison of small farm systems

System (a)	Total Net Value of production (b) (₡)	Total Adult male equivalent hours used (b)	Net value of production per hour (₡) (b)	Ha. of land used
1. R-B, 4C-4B	22,986.20	2145 (54%)	10.72	10
2. R-B, 2C-2B, 2C	17,786.20	1825 (46%)	9.74	8
3. C-C, C-B, R-B 4 TA	23,942.95	2035 (51%)	11.76	10
4. 2C-2B, R-B 4 TA	24,559.70	1945 (49%)	12.63	10
5. 4C-4B, 2 IT	26,712.68	2302 (58%)	11.60	10
6. 5C-3B, 2 IT	26,095.93	2392 (60%)	10.91	10

(a) R=rice; C=corn; B=beans; TA=traditional achiote; IT=intensive achiote.

(b) These columns represent earnings, costs and labor requirements of an established achiote grove. The figures presented here do not take into account hours or costs incurred in establishing the grove.

in a total net value of production of ₡26,095.93, would use 2392 hrs of the family's adult male equivalent labor supply (60%) and would have an hourly labor return of ₡10.91.

Table 15 summarizes the net value of production, adult male equivalent hour use, net value of production per hour, and hectares of land use information for the farming systems presented thus far. When examining Table 15, one must keep in mind that the price used to calculate net value of production for achiote could easily be at least ₡20/qq higher and therefore the total net value of production for systems including achiote might be at least ₡1500 higher for traditional achiote farming systems, and ₡750-1760 higher for intensive achiote farming systems (₡750 considers only a price of ₡161.89/qq; ₡1760 is based on a price of ₡161.89/qq and a yield of 44qq/ha). Table 15 demonstrates that farming systems including achiote have higher total net value of production figures, allow the farmer to use all his land without requiring that he plant five hectares of beans during November and use more labor than the non-achiote systems. Table 15 also shows that intensive achiote systems will provide the family with a higher net value of production (and hence higher incomes) than will traditional achiote systems. System 2 in Table 15, approximates the farming system followed by small farmers in the Quepos area who grow only corn, beans and rice. The net value of production for a farming system which includes intensive achiote, such as system 5, is 46.7% higher than the net value of production for system 2. System 5 also uses 31% more labor than system 2. This shows how inclusion of a high value crop with a slightly different labor requirement pattern can help small farmers make better use of their labor resources and increase their family's income.

Another advantage of achiote production is that achiote helps decrease the risks a farmer must contend with. Achiote helps reduce the farmer's management risk by evening out his labor requirements pattern. Since achiote doesn't need to be planted each year, and its harvest does not coincide exactly with corn, bean and rice harvests, achiote production helps the farmer use more labor and more land than the typical corn, bean and rice farmer without requiring a higher level of management skills. Achiote decreases market risks by diversifying the farmer's set of products, and consequently reduces his dependence on basis grain prices (and revenue) as a source of income. Achiote also decreases weather related risks because it is a hardy plant and usually is not seriously affected by heavy rains or mild droughts which might ruin an annual crop. Thus one sees that inclusion of a perennial crop such as achiote could have an important impact on small farmer well-being because it reduces risk in a variety of ways and adds stability to the farming system at the same time it helps the farmer achieve a higher income.

<u>Should the Cooperative Finance Traditional and Intensive Achiote Plantings or only Intensive Achiote Plantings</u>

Considering the lack of information on labor requirements, yields, and costs of maintaining an intensive achiote planting it would be best to let farmers decide for themselves if they want to experiment with intensive achiote instead of pressuring them to do so. Table 14B pointed out that an intensive achiote yield of 33 qq/ha does not provide as high a return per hour as can be earned from traditional achiote production (₡12.66 vs ₡17.32). Intensive achiote hourly labor returns will not reach the ₡17.32 figure unless intensive yields are 44 qq/ha (or labor requirements estimates for intensive achiote are lowered). Table 12 suggests that 44 qq/ha is not an unreachable target yield, but it is above the yields currently being attained by farmers in Central America. Until there is evidence that intensive returns/hr of labor effort are at least equal to traditional returns, the cooperative should be willing to finance both traditional and intensive achiote plantings.

How Many Additional Hectares of Achiote Should the Cooperative Finance

If the cooperative's goal is to quadruple current dried seed production with the intent of surpassing the 400 MT production level needed to attract a processing plant, 465 additional hectares of traditional achiote or 267 additional hectares of intensive achiote should be enough to meet this goal. Approximately 100 additional families would need to incorporate achiote into their farming systems to generate this type of production increase assumming each family produced 4ha of traditional achiote or two ha of intensive achiote. If a processing plant is established in Costa Rica, the total number of families required to produce achiote for the plant and the local market would be at least 250 and might be as high as 600. While these numbers are not large, one must keep in mind that these are only the numbers of the families needed for producing raw material. Other people will be needed to build and work in the processing plant, and the multiplier effect caused by increased incomes of producing and processing families should generate considerable increases in gross regional product and local employment opportunities which would help slow out migration from achiote producing areas. Thus the long run consequences of establishing an achiote industry are potentially important and impressive.

Although future benefits to Cooperative members and to Costa Rica appear promising, it would not be advisable for the cooperative to begin large scale expansions of achiote production this year. Achiote, like many other export crops, has been fairly risky in the past. Achiote dried seed prices have fluctuated from $0.15/lb to $0.60/lb FOB shipping port during the past ten years. Part of this variability is due to inflation, part to transport cost differences, part to seed quality, and part to supply fluctuations.

Demand for achiote appears to be fairly constant and growing slowly. There is a possibility that bans on chemical food colorants may cause increases in demand, but this is not certain. Achiote doesn't appear to be a suitable replacement for Red Dye 2 or Red Dye 40 (the two dyes which are currently prohibited), and consequently one cannot count on their prohibition as evidence that demand will increase. At the same time, one should not assume these bans will have no effect on demand. There are probably a number of food processes currently using chemical colorants in which achiote's extract could be substituted. The recent price increases for dried achiote seed (see Table 7) suggest that this substitution may be taking place and that demand may be growing.

Table 16 presents estimates for dried seed imports in the United States and several other countries. As can be seen from Table 16, US imports in the past have been fairly modest in terms of metric tons and in terms of hectares of land needed for production. The cooperative's current production (200 qq of paste, equivalent to 115 MT of dried seed -- 134 ha of traditional achiote) represents approximately 4% of US annual imports. If an additional 400 MT of seed were produced in Costa Rica with the intent of exporting it to the United States, prices would probably decrease (assuming exports from other countries stayed at current levels). There is, however, a possibility that Costa Rica has a comparative advantage in achiote production because of its ecological system and its closeness to the United States. If this is the case, Costa Rica may be able to compete effectively with Kenya, Peru, Colombia, Bolivia or Brasil for a share of the existing US market or a share of an expanding market in the future. Thus, Costa Rica might be able to market a considerable amount of achiote if production were expanded over a period of years to provide an additional 400 MT which could be exported initially, and would subsequently provide the basis for convincing Kalsec (or some other

TABLE 16.- Dried Achiote seed import estimates for selected countries.

Source	Country	Dried seed imported per year (metric tons)	Countries currently supplying imports	Prices/lb
Kalamazor Spice Extraction Company and Miles Laboratories, Marschall Dairy Division	USA	500-2000	Kenya, Ecuador Dominican Republic, Peru, Colombia, and Jamaica	$0.12-0.60 per lb f.o.b. shipping point
Prasad Patnaik[(a)]	USA Russia United Kingdom Japan	30-50 100-150 30-50 25-30		
R. L. Booth of Pfizer Milwaukee	USA	2600-2800		$0.30-0.45

(a) Prasad Patnaik, Bhagbat, Indian Farming, "Annatto Can Fetch Foreign Exchange," January 1971, pp. 28-30.

company) that a processing plant should be located in Costa Rica. Four hundred metric tons is about 15% of US annual imports in recent years. Whether or not Costa Rica could take over 15% of the US market is unknown. It cannot even be estimated satisfactorily until more is known about yields, labor requirements, seed quality and costs of drying, packing and transporting seed in 20 MT trailer loads. One lb seed samples need to be sent to importers for price estimates and one or more trial shipments of 10 or 20 MT should be arranged as soon as possible to see what types of problems are involved in seed exports. Kalsec has indicated to Thomas R. Pierson, Asst. Prof. of Agricultural Economics at Michigan State University, that they have experienced severe molding problems with achiote from South America and the Caribbean. If the cooperative can overcome this type of problem by mechanical drying and proper handling, a portion of the US market may be opened up to Costa Rican exports. Still, one cannot assume a market share of 400 metric tons will automatically be forthcoming, and it is premature to expand planting area to produce an additional 400 MT of dried seed at this time.

Local market demand for achiote paste (and possibly seeds) may also be growing. The decision by Aguilar and Solis to purchase 50 qq of dry paste for use in concentrated chicken feed suggests the local market may be capable of absorbing considerably more achiote than was previously thought possible. In addition, work underway at the University of Costa Rica raises the possibility that both achiote and yuca flour may experience increased demands for use in animal concentrates. Analysis of dried achiote by the University of Florida (Latin American Tables of Food Composition, 1974) shows that achiote seeds with hulls have approximately 25% digestible protein when fed to horses, cattle or sheep. Thus there may be significant increases in local (and perhaps export) demands for both of these crops.

Given the possibility of demand increases in local and export markets, the cooperative should be willing to help farmers expand achiote production, but at the same time stress the fact that this could be risky. Individual farmers should be encouraged to limit present expansion to one hectare of traditional achiote or 1/2 hectare of intensive achiote this year. This would keep each farmer's initial investment low enough so that financing may not be necessary. In cases where financing is necessary, the total amount will be small enough to allow easy repayment from future achiote paste or seed sales as new trees come into production. It would also be helpful if credit were provided in the form of inputs which could be bought in bulk by the cooperative. As farmers come in to pick up these inputs, an extension agent or other expert could give advice on how to apply them to obtain desired results.

If increased plantings were limited to 1/2 or 1 hectare per farmer and 100 farmers were interested in expanding production this year, achiote dried seed production should increase by approximately 1000 qq in 1978 and 2000 qq in 1979. This should be enough to meet immediate local market demand increases and would provide a small amount for trial export sales. This strategy would allow the cooperative to find out more about: (1) bixin content and yields of different varieties; (2) costs, yields and labor requirements of intensive production; (3) the costs and problems involved in drying, packing and exporting dried seed; and (4) fluctuations in export prices and value of Costa Rican seed in export markets. As more becomes known about local and export demands and Costa Rica's ability to compete in export markets, plantings may be increased or decreased accordingly.

<u>The role of the Cooperative</u>

One pitfall which the cooperative should avoid is to think of itself simply as an achiote production or marketing cooperative. The cooperative should work with extension agents and others in helping farmers develop local technological packages to improve yields of corn, beans and rice, and should become involved in input purchasing and marketing activities for these crops as well. With the assistance of MAG personnel and other experts, the cooperative should look for additional crops which could be added to the corn, bean, rice and achiote systems described here. If the cooperative is to serve its members best interests it will be a focal point for technical assistance in a variety of areas such as: improved crop production technology, adult education, nutritional contents of various food combinations, home economics, community recreation, small animal additions to current farming systems, community development, production and consumer credit, marketing, and other areas. While achiote marketing has been the focal point which brought the members together, it represents only a small part of the complete package of benefits which could accrue to cooperative and community members.

Erosion Control

Achiote is a valuable addition to the small farmer's set of cropping systems because it is a perennial crop and thus helps control erosion. Since most achiote near Quepos is grown on hillsides, this is an important consideration. Once achiote trees become established, forage grasses might be sown among them to provide pasture for horses and/or cattle. Studies should be initiated to determine the seriousness of competition between achiote and forage grasses to ascertain the viability of achiote and pasture intercropping systems which would reduce erosion, provide pasture for animals and increase incomes of small farm families.

Erosion control is an important problem in many areas, and consequently one should keep in mind that achiote is only one of a series of perennial crops that may be considered for inclusion in small farming systems. Thus while this paper deals specifically with achiote, it also provides a methodology for analyzing how other perennial crops could contribute to the well being of small farm families.

<u>The Role of CATIE in Achiote Investigation</u>

The Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) is currently engaged in small farm cropping systems research throughout Central America. CATIE has assembled a highly competent team of agricultural experts that could devote part of their research efforts to achiote if INFOCOOP (or some other institution) would provide founding for materials, viaticos, laborers, etc.

CATIE would be a natural focal point for achiote investigations because of its existing contacts with MAG and its experience in working with small farming systems. This experience is very important in evaluating the amount of a new crop small farmers will be able to produce and in determing which technological packages would be most appropriate for small farm achiote production. CATIE has an established, producing collection of achiote varieties that could be used as a starting point for varietal selections and comparisons. This collection would be invaluable as a source of raw material for propagating promising varieties. By negotiating a joint research contract between CATIE and MAG, INFOCOOP could advance achiote research by at least two or three years. This time savings would be very important if demand increased rapidly during the next few years.

TABLE A1.- Corn production activities followed by small farmers in the Quepos area.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITY	MATERIALS USED	JORNALES REQUIRED
1. Land preparation			
a) Slash and burn, the predominant method	8 days before planting	machete(s)	8
b) Brush clearing or "raspada"	15-22 days before planting	machete(s)	8
2. Curing of seed and planting	First planting is 15 March-15 April Second Planting is 1 Oct.-1 Nov. Planting dates may vary a little	One oz of agallol or Aldrin to cure the seed. 32 lbs of local seed, planting distance is 1 m between rows and 60 cm between hills	8
3. First weed control	30 days after planting	One liter Esterón, Tributón or Gezaprin One back sprayer	4
4. Fertilization	30-35 days after planting	100 kilos area	4
5. Doblada	90 days after planting	machete(s)	3

TABLE 11.- (continued)

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITY	MATERIALS USED	JORNALES REQUIRED
6. Harvest ears	4-5 months after planting	sacks	10-12
7. Shell and dry the grain	The week after harvesting the		5 sunny days
8. Transport to the house	The week after shelling and drying	horse(s)	5-7 depending on the yield and the distance
9. Sale of grain	Corn is sold bit by bit as money is needed for purchases		

TABLE **A2**.- Bean production activities followed by small farmers in the Quepos area.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITY	MATERIALS USED	JORNALES REQUIRED
1. Land preparation and planting. Seed is broadcast and then grass is cut to cover the seed (Siembra tapada)	1 Nov.-30 Nov.	50 lbs of local seed machete(s) file	12
2. Harvest bean plants and carry them to the house	60-65 days after planting	sacks	18
3. Thresh and dry beans	one week after harvest		2
4. Sale	beans are sold bit by bit as money is needed		

TABLE A3.- Rice production activities followed by small farmers in the Quepos area.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITY	MATERIALS USED	JORNALES REQUIRED
1. Land preparation, slash and burn	one week before planting	machete(s)	3
2. Planting	15 March-15 May	64 lbs of rice. Rice is planted in rows 16 inches apart with 8 inches between hills	16
3. First weed control	30 days after planting	1 liter esterone Back pack sprayer	4
4. Second weed control (by hand)	45 days after planting		4
5. Harvest, thresh, clean and put in sacks	180 days after planting	Cycle(s) and surillo machete(s) twenty 160 lb sacks	20
6. Transport to the house	180-190 days after planting		4
7. Dry	190-192 days after planting		4 sunny days
8. Husk the rice using a mechanical husker	192-193 days after planting	rent husker, ₡8/qq	1
9. Sell rice	193-197 days after planting		8

TABLE A4.- Traditional achiote production activities in the Quepos Area- Year 1.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITY	MATERIALS USED	JORNALES REQUIRED
1. Land Preparation			
a) clearing and burning	1 Feb.-30 March	Axe(s), machete(s)	18
b) cut stakes	1 April - 30 April	Machete(s)	4
c) dig holes for seedlings	1 May - 30 May	Shovel(s)	2
2. Transport and transplant seedlings	1 May - 30 May	830 seedlings/ha planted "al tresbolillo" 3x4 M, seedlings are valued at ₡0.25 each. Shovels, horse	5
3. Replant seedlings which die	1 June-30 June	42 seedlings at a 5% loss rate shovels	1
4. First brush clearing	1 Aug.-31 Aug.	Machete(s)	6
5. Second brush clearing	1 Nov.-30 Nov.	Machete(s)	6

TABLE A5.- Traditional achiote production activities in the Quepos Area - Year 2.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITIES	MATERIALS USED	JORNALES REQUIRED
1.- First brush clearing	1 June-31 June	machete(s)	6
2.- Second brush clearing	1 Sept.-30 Sept.	machete(s)	6
3.- Harvest pods and prune	1 Oct.-31 Oct.	machete(s), sack(s)	5
4.- Boil pods to make paste	1 Oct.-31 Oct.	pot(s), kettle(s)	5
5.- Transport and sale	1 Nov.-31 Dec.	horse, one horse can carry 150 lbs of paste	1

TABLE A6.- Traditional achiote production activities in the Quepos Area - Year 3 and subsequent years.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITIES	MATERIALS USED	JORNALES REQUIRED
1.- First brush clearing	1 June-31 June	machete(s)	6
2.- Second brush clearing	1 Sept.-30 Sept.	machete(s)	6
3.- Harvest pods and prune	1 Oct.-31 Oct.	machete(s), sack(s)	10
4.- Boil pods to make paste	1 Oct.-31 Oct.	pot(s), kettle(s)	8
5.- Transport and sale	1 Nov.-31 Dec.	horse, one horse can carry 150 lbs of paste which is the yield for 1 ha of 3 yr old trees	1

TABLE A7.- Yield, home consumption, price and gross value of production information for small farmers in the Quepos area.

Crop	Yield/ha	Human and Animal consumption/year*	Price the farmer receives	Gross value of Production/ha
Corn, 1st and 2nd planting	30-40 qq	20 qq	₡60-₡65/qq	₡1,800-₡2,600
Beans, 2nd planting	12-15 qq	4 qq	₡200/qq	₡2,400-₡3,000
Rice, 1st planting	20 qq (apilado)	10-12 qq	₡120/qq	₡2,400
Achiote (mature trees)	150 lbs paste		₡18-₡20 lb	₡2,700-₡3,000

* For a typical family of 10 members.

TABLE A8.- Intensive achiote production activities on one hectare of land in the Quepos Area - Year 1.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITIES	MATERIALS USED	JORNALES REQUIRED
1. Land preparation			
a) clearing and burning	1 Feb.-30 March	axe(s); machetes	19
b) cut (and place) stakes	1 April-30 April	machete(s)	5
2. Dig holes; fill with organic matter and soil; transport seedlings and organic matter; and transplant seedlings	1 May-30 May	700 seedlings are planted per hectare, seedlings are planted "al tresbolillo", 3.5x4m, seedlings are valued at ₡0.10 apiece or ₡70/ha; shovel(s); horse(s)	12
3. Transport and retransplant seedlings that die	1 June-30 June	70 seedlings will need to be replanted, therefore costs are ₡7/ha, shovels horse(s)	0.6
4. First weed control, fertilization and 1st fungicide and/or insecticide application	1 Aug.-31 Aug.	Machete(s), back pack sprayer, ₡21.50 worth of fungicide and/or insecticide; ₡214.50 of fertilizer; horse(s)	17.1
5. Second weed control and second fungicide and/or insecticide application	1 Nov.-30 Nov.	Machete(s), back pack sprayer, ₡21.50 worth of fungicide and/or insecticide	15.1

TABLE A9.- Intensive achiote production activities on one hectare of land in the Quepos Area - Year 2.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITIES	MATERIALS USED	JORNALES REQUIRED
1. First weed control or cultivation. First application of fungicide and/or insecticide; fertilization	1 June-31 June	machete(s); ₡420 of fertilizer, back pack sprayer; ₡28.60 of insecticide and/or fungicide	14.8
2. Second weed control or cultivation; 2nd application of fungicide and/or insecticide	1 Aug.-30 Sept.	machete(s); ₡28.60 of insecticide and/or fungicide	12.8
3. Prune; harvest pods; boil pods to make paste	1 Oct.-31 Oct.	machete(s); sack(s) pot(s) or kettle(s)	30.0
4. Transport and sale	1 Nov.-30 Nov.	Horse; yield at the end of the 2nd year is 14qq of seed or 110 lbs paste	1.0

TABLE A10.- Intensive achiote production activities on one hectare of land in the Quepos Area - Year 3 and subsequent years.

PRODUCTION ACTIVITIES	CHRONOLOGY OF THE ACTIVITIES	MATERIALS USED	JORNALES REQUIRED
1. First weed control or cultivation; first application of insecticide and/or fungicide	1 June-31 June	machete(s); ₡420 of fertilizer; back pack sprayer; ₡28.60 of insecticide and/or fungicide	14.8
2. Second weed control or cultivation; 2nd application of insecticide and/or fungicide	1 Aug.-31 Sept.	machete(s); back pack sprayer; ₡28.60 of insecticide and/or fungicide	12.8
3. Prune; harvest pods; boil pods to make paste	1 Oct.-31 Oct.	machete(s); sack(s) pot(s) or kettle(s)	36.6
4. Transport and sale	1 Nov.-31 Dec.	Horse; yield at the end of the 3rd year is 21.45 qq seeds or 171.6 lbs paste [(a)]	2.0

(a) This is a conservative yield. Under normal conditions paste yields have been as high as 300-350 lbs per hectare. Thus the yield figure here of 171.6 lbs of paste can be regarded as a minimun figure for a normal intensive achiote grove. An average paste yield for an intensive achiote grove might be approximately 250 lbs/ha.

APPENDIX B

TABLE B1.- Variable inputs used in one ha of corn production

Variable Input	Amount used/ha	Cost (₡)	Cost/ha (₡)
Seed	32 lbs	0.625/lb	20.00
Aldrin 25%	1 oz	1.25/oz	1.25
Diuron	1 lb	27.00/lb	27.00
Urea 45%	100 kilos	78.00/100 kilos	156.00
			204.25

TABLE B2.- Variable inputs used in one ha of rice production

Variable Input	Amount used/ha	Cost (₡)	Cost/ha (₡)
Seed	64 lbs	1.20/lb	76.80
Propanil, 4 lbs/gal	1 gal	110/gal	110.00
Shelling cost	20 qq	8/qq	160.00
			346.80

APPENDIX B

TABLE B3.- Variable inputs used in one ha of bean production.

Variable input	Amount used/ha	Cost (₡)	Cost/ha (₡)
Seed	50 lbs	20/lb	100

TABLE B4.- Inputs used for one ha of traditional achiote.

Variable input	Amount used/ha	Cost (₡)	Cost/ha (₡)
Seedling costs in year one	830	0.25/each	207.5*

*Since the seedlings will grow to trees that should produce for at least 10 years, this is roughly equivalent to an annual cost figure of ₡15/yr. Note that this is not a variable cost. It is a fixed cost and is mentioned here because it is the only non labor cost used in traditional achiote production (with the exception of those capital goods such as sacks, machetes, pots, etc. which the farmer uses for a variety of crops and purposes).

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