ANNEX G : MARKETING OF PRODUCTS AND AGRO-INDUSTRY

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G.1 MARKETING OF PRODUCTS

G.1.1 Actual Situation

(1) General description

Agricultural production in the Department of Quindio is represented by coffee and other traditional crops such as plantain, cassava, orange, etc. These are also major crops produced in the study area accounting for almost 80% of the total area for crops. Apart from these traditional crops, only soybean and sorghum are conspicuous in terms of cultivated area. Recently, supported by the Bureau of Agriculture of the Departmental Office and other institutions, production of such non-traditional fruits as tree tomato, "lulo" and "cruba" are increasing in mountain areas, but their output is negligible within the total output of the study area. Meanwhile, vegetables are scarcely cultivated in the study area except for tomato which is produced in excess of local demand.

As a consequence of concentration of farming activity on some limited crops, many foodstuffs required for diet of the Quindian people are provided from other departments. Information on balance between production and consumption of crops within the Department of Quindio is not available, but Table G.1.1-major perishable crops purchased by supermarket for their sale in Quindio intimates some characteristic aspect of the said balance. According to the table, of leading ten crops much consumed in Quindio, only Salento potato, tomato and banana are supplied from farmers in Quindio. This phenomenon has compelled consumers in Armenia to buy food higher price in comparison with other major cities of the country such as Bogota, Medellin and Cali as well as adjacent cities consist of Manizales and Pereira (see Fig. G.1.1).

Higher price of foodstuffs is also attributable to their

complicated distribution system from farmers to final consumers; as Fig. G.1.1 indicates, in Armenia prices of cassava, plantain, tomato and orange-leading crops in the region are also the highest among the said six cities or higher than most of these cities. Small farmers who grow these crops do not possess vehicle to transport their products from farm to wholesale or retail markets, thus intermediaries intervene this marketing channel and prices of crops are elevated accordingly.

Marketing condition for respective product is explained hereinunder.

(2) Coffee

Coffee has been almost the only exportable product among those produced in the Department of Quindio as well as in the study area; it contributes 97-99% of foreign exchange earning of the Department and accounted for 5% of the total FOB value of the total national export of coffee in 1987 (See Table G.1.2).

Harvested coffee cherries are deprived of their pulps by growers themselves and thus pulped coffee beans are dried and sold to private exporters, cooperatives and Almacafe (in 1989 the share for respective agency was 59%, 26% and 15%-information from Almacafe). Pulped and dried coffee beans are threshed at private factories and then distributed whether to an international market (to Europe and Japan by threshing factories and to U.S.A. by Almacafe) or to domestic market (to milling factories). In 1989, close to three quarters of the departmental production were exported.

Colombian coffee's price at international market has been depressed ever since 1986's coffee bonanza had passed away. In 1990 (Jan.-Sept.), coffee's international price averaged at US$ 0.95/pound, which is the lowest annual quotation since 1976. Under such dull

performance of of coffee's price at an international market, it is reported that coffee growers in the world except for Colombia are suffering from decrease of income in 1990 compared with the proceeding years.

On the other hand, domestic price was adjusted on September 4, 1990 from Col$. 604/kg to Col$. 680, and with this adjustment it has been hiked in more than 30% for the last 12 months.

As a result of this contrast in behavior, the international price in 1990 was lowered by 36% in comparison with that in 1985, while the domestic price was boosted by 29% between 1985-1990 even if 1990's price was deflated taking account of inflation factor. Consequently, the balance between international and domestic prices was shrunk to US$ 0.87/pound- one-third of the 1986's level and the lowest for the last 10 years (Refer to Table G.1.4).

(3) Plantain and cassava

Plantain and cassava are other staple products which have attained high reputation in the leading markets in the country represented by Bogota, Medellin and Cali. Around 70% of plantains produced in Quindio are traded out of the Department through wholesalers who get the product directly from farmers, while the remaining proportion are distributed locally through an intervention of intermediaries. On the other hand, about 60% of departmental production of cassava are transported to wholesale markets in Bogota and and other major markets of the country.

An excessive intervention of intermediaries in the trade of plantain and cassava has affected unfavorably both farmers and consumers; as explained before, consumer's prices of plantain and cassava in Armenia are higher than those in the leading municipalities of the country.

(4) Orange and passion fruit

The greater portion of orange and passion fruit are planted in both margins of the Quindio River.

Apart from coffee, plantain and cassava, orange is other crop which is distributed to regions other than Quindio; about 80% of the production in Quindio is traded there. Presently, without having local wholesale market, intermediaries purchase the fruit directly from farmers for distributing it to Bogota and other major municipalities' markets. It is reported that there are substantial loss (about one-third of the production) of post-harvest due to inadequate handling, packing and transportation practice.

Following the diversification program promoted by the Coffee Committee, a processing plant is constructed aiming at to start its operation in July 1991. With this operation, the majority of orange to be produced in the project area will be distributed to the plant and farmers will be benefited eliminating an intervention of intermediaries.

The production of passion fruit is increasing not only in the study area but only in Quindio as a whole. Within the study area, this fruit is just introduced in parallel with the start of two processing plants located in La Union (Valle) and Chinchina (Caldas); in case of the latter, the owner of the plant-Passicol S.A. is promoting the production providing interested farmers with inputs with lower prices, offering supporting price for associates members of farmers, and rendering technical assistance free of charge.

(5) Soybean, sorghum and other grains

Soybean and sorghum are produced under mechanized farming in relatively lower and flat lands situated on both margins of the Quindio River.

In the national level, soybean is the second crop next to wheat in terms of importation volume among agro-products and reflecting this situation its production is encouraged by the government aiming at saving foreign exchange.

Soybeans produced in the study area are purchased totally by food oil manufacturing factories or their agents in the Department of Valle, thus no major constraint is found for their marketing up to date. Sorghums, on the other hand, are generally sold to intermediaries in Armenia or other municipalities nearby and they are thereafter processed for making animal feed. In the national level, soybeans and sorghums are included in crops which are purchased by IDEMA on the basis of supporting prices established by the institution every semester. Nevertheless, IDEMA's sub-regional office in Armenia has not entered in the trade of these crops for the last four years.

The greater portion of maize and beans are cultivated inconsistently in available space of lands for coffee production in time of renovation of the plant. Considerable portion of these grains are kept for self-consumption of farmers' family and farm workers, whereas those purchased by intermediaries are traded at markets where they are produced or sold to retailers in Armenia.

(6) Vegetables and minor fruits

The production of vegetables and minor fruits in marginal areas for coffee production is currently encouraged intensively by the Coffee Committee, the Bureau of Agriculture of the Departmental government Office, and other relevant institutions, because their output in Quindio corresponds to as low as 35% and 5% of the local demand (information provided by FDQ, "Encuesta a Mayorista", 1986).

Among this category of crops, only tomato is produced in excess of

local demand. More than half of the demand in Quindio for vegetables are satisfied with supply from the Department of Cundinamarca through intermediaries or retailers, meanwhile minor fruits consumed in Quindio are supplied in their 60% from Valle and 20% from Tolima.

In Quindio, vegetables and minor fruits are generally traded channels. viz:

- Small scale retailers purchase at sites where they are produced and distribute directly to consumers.

- Farmers transport their products by themselves to supermarkets, retailers' markets, restaurants, etc.

These marketing channel is not consolidated, because the output fluctuates largely provoked by farmers' inclination of cultivation on speculation. The behavior of price and traded volume for some vegetables and fruits at Corabastos in Bogota is as per attached Fig. G.1.3.

(7) Meat and dairy products

Production of cattle meat in Quindio is deficient and local demand is satisfied with supply from other departments. This supply of meat is handled by eight wholesalers exclusively. These meat are originated from not only neighboring departments such as Valle, Tolima and Antioquia, but also from Sucre and Cordoba-departments facing with the Atlantic Ocean. Animals' trade within Quindio is also conducted through the said wholesalers, and distribution of meat to consumers is made by means of other wholesalers stationed in areas other than Armenia, retailers, supermarkets, etc.

The rate of self-sufficiency of dairy products is very low-about

8%, and the lacking portion is satisfied with distribution from Valle and other departments.

The leading marketing channel of milk at the local level is that intermediaries called "crudero" get crude milk directly from dairy farmers to distribute it to processing agents.

G.1.2 Perspective for Marketing of Major Agro-products

(1) Coffee

As explained in the foregoing sub-section, an international price of coffee has been depressed after the 1986's coffee bonanza had passed away, but farm-gate price has been hiked with the rate superior to an inflation rate. If costs for export (threshing, local transportation, port handling, insurance, freight, etc.) is taken into account, it can be concluded that the international price is inferior to the farm-gate price. This means that the National Coffee Fund (FNC) is subsidizing coffee growers to compensate the deficit between the international price and the farm-gate price. As a result, the FNC's financial situation become deteriorated cutting through its savings accumulated up to date.

Under the circumstances, it is supposed that coffee growers would not be able to anticipate an elevation of price as they desire in the future, because:

a. There would be few possibility that coffee's pact would be concluded by the International Coffee Organization (ICO) in near future, and, without the pact, coffee's price at international market would remain depressed as it is at present; under the circumstances, the financial situation of the FNC will turn to tight and, as a consequence, the FNC will not be able to afford to raise farm-fate price in such

level as it satisfies coffee growers.

b. The primary concern of the Administration of the President Gaviria is to control inflation and in compliance with its policy, it has been decided to freeze supporting prices for some cereals (others are to be raised their prices, but they are as low as in the range of 1-3%). In this connection, only coffee can not be favored with the government's support.

(2) Plantain and cassava

Plantain is one of crops which production is promoted by the Departmental Coffee Committee within its diversification plan, therefore is output is projected to be expanded drastically.

The existing marketing channel of plantain is not consolidated (the greater portion of plantains are distributed to the "Plaza de Retiro", the facilities of which are old and not working effectively), thus to cope with an expansion in output, it is prerequisite to reconstruct the existing facilities or to develop new infrastructure.

Cassava's cultivation has been controlled by CRQ aiming at mitigating soil erosion, and following CRQ's regulation, the cultivated area for the crop was declined for the last few years. Nevertheless, in view of high returns to be expected for the crop, it is presumed that the cultivated area of cassava as well as its output would not be reduced anymore.

(3) Soybean and sorghum

Supporting prices for grains had been appreciated for the last few years in accordance with "Selected Crops' Production Expansion Plan (Plan de Oferta Selectiva)" employed by the administration of

the President Barco. But under the tight economic policy of the of the actual President Gaviria, farmers engaging in cultivation of grains would not be favored with rise in supporting price.

Despite this disadvantageous circumstances, production of soybean and sorghum shall remain prosperous for farmers in the study area, because there exist some factories for processing these products in the Department of Valle which purchase the whole production in the area directly from farmers.

(4) Citrus

Because an operation of new processing factory within the Department of Quindio is envisaged very soon citrus constituting raw materials for this factory are promised to be called for high demand. Furthermore, an installation of this factory will benefit farmers in connection with farm-gate price of citrus, because farmers can trade with owner of the factory without being exploited margins by intermediaries.

(5) Vegetables and minor fruits

Tomato is one of the most profitable product among those produced in the study area, but its cultivation in large amount is not feasible. The price of tomato fluctuate greatly according with its transacted volume. So as to secure farmers with more stable farming economy of tomato, it is imperative that circumstances to obtain up-to-dated and reliable marketing information should be established.

Onion is at present scarcely produced in quindio and local demand is satisfied with supply from Risaralda and Corabastos de Bogota. This crop may be cultivated in large scale (some farm in Risaralda has cultivated area of 15 has.) and harvest is expected four times

a year. The yield is around 40 ton/ha/year and gross return of Col$ 4,800,000/ha/year is anticipated (information obtained at Florida, Risararda).

Blackberry, tree tomato and "lulo" are fruits which are generally consumed after being processed to juice and demand for them is high within the region. These products are also processed to produce frozen concentrated juice, so their expansion in output will give local economy with an incentive to develop an agro-industry. Besides, tree tomato has a possibility to be traded at international market (the fruit produced in Cajamarca, Tolima is exported to German).

Pitaya-a Colombian origin tropical fruit had been exported to Japan, but due to sanitary problem (appearance of Mediterranean fly) its export is actually suspended. At present, an effort has been made between the Governments of Japan and Colombia to take measures for solution of the problem.

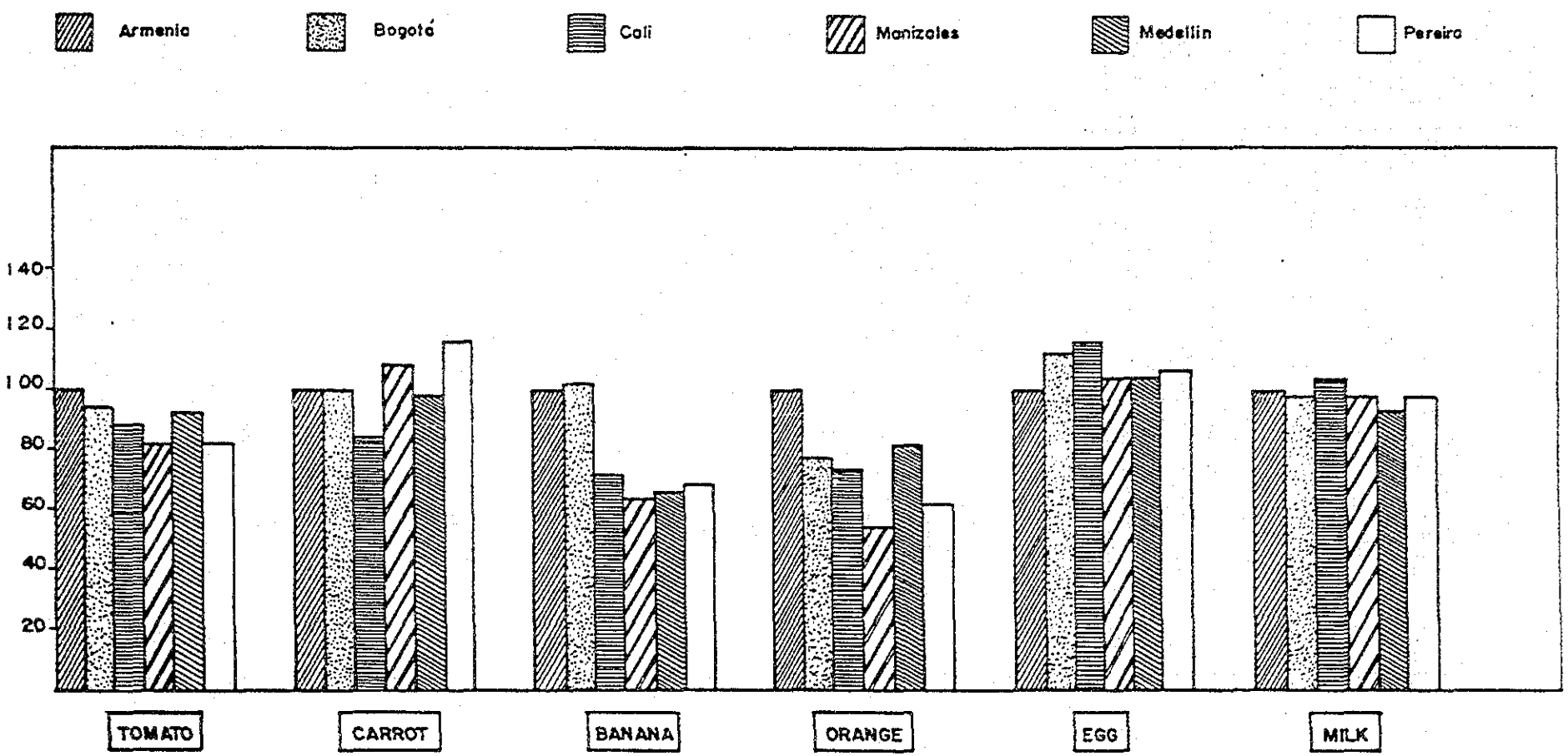


FIG. G.1.1 (1) COMPARISON OF RETAIL PRICE
(AVERAGE 1988-1989; ARMENIA: 100)

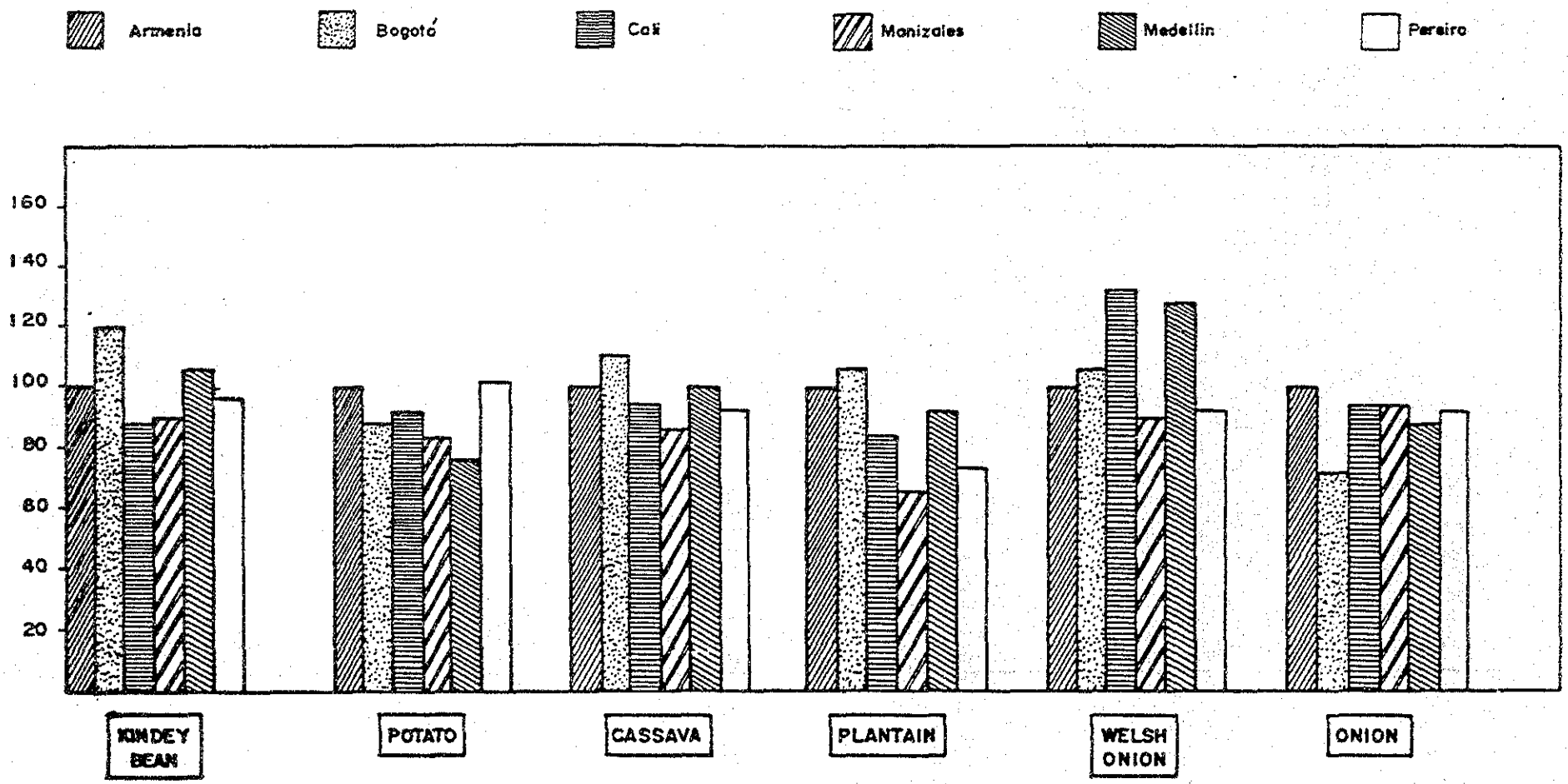


FIG. G.1.1 (2) COMPARISON OF RETAIL PRICE
(AVERAGE 1988-1989; ARMENIA: 100)

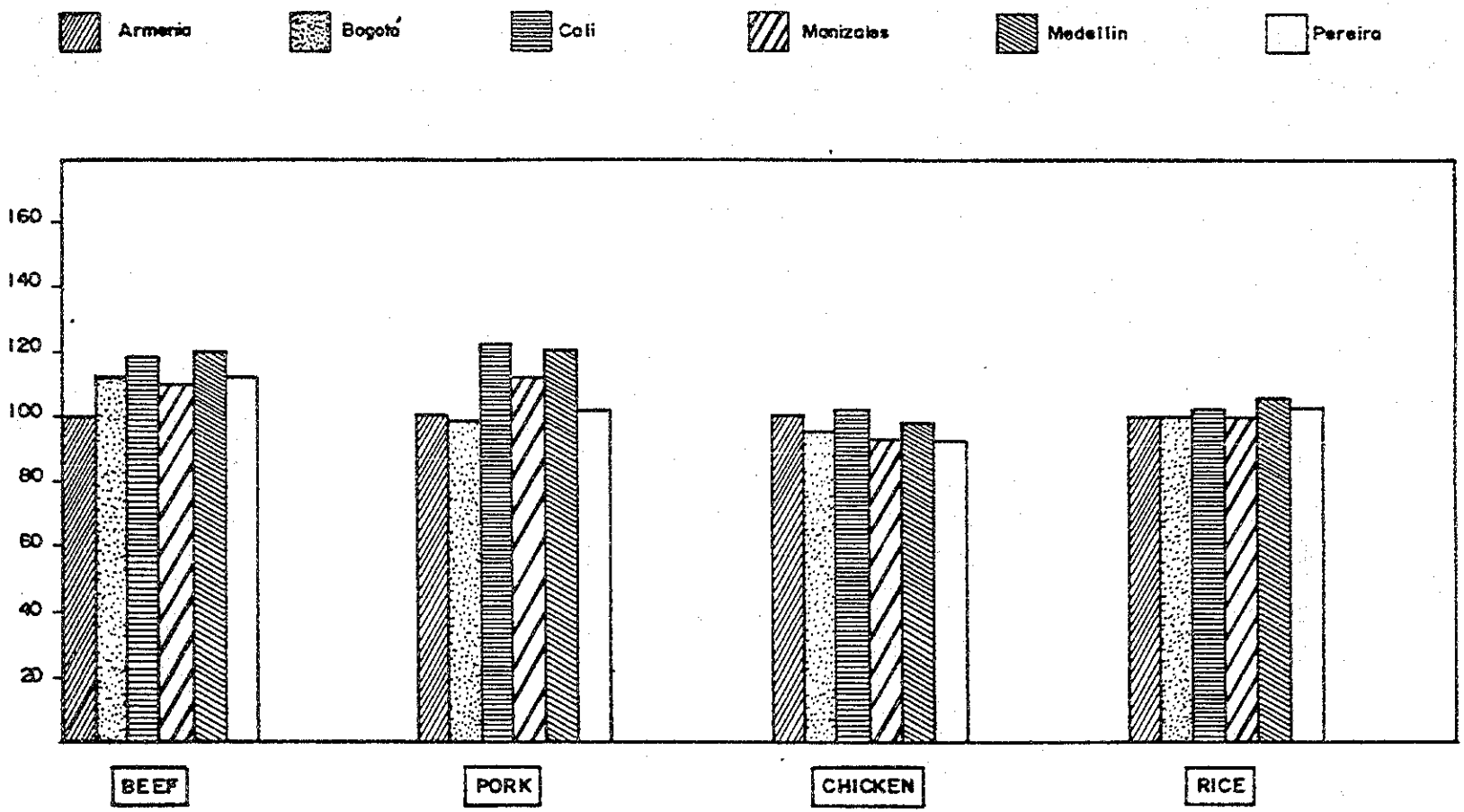


FIG. G.1.1 (3) COMPARISON OF RETAIL PRICE
(AVERAGE 1988-1989; ARMENIA: 100)

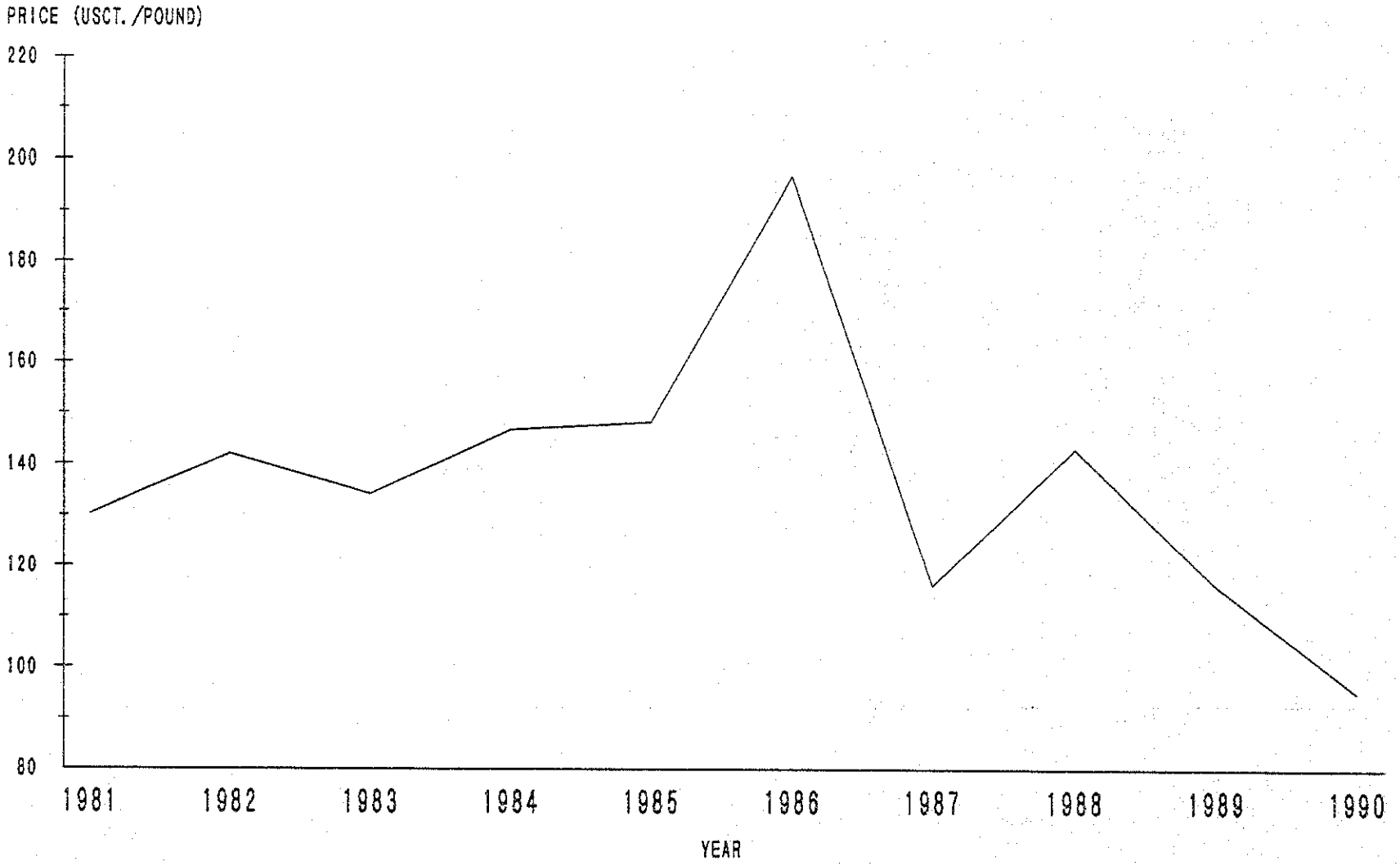
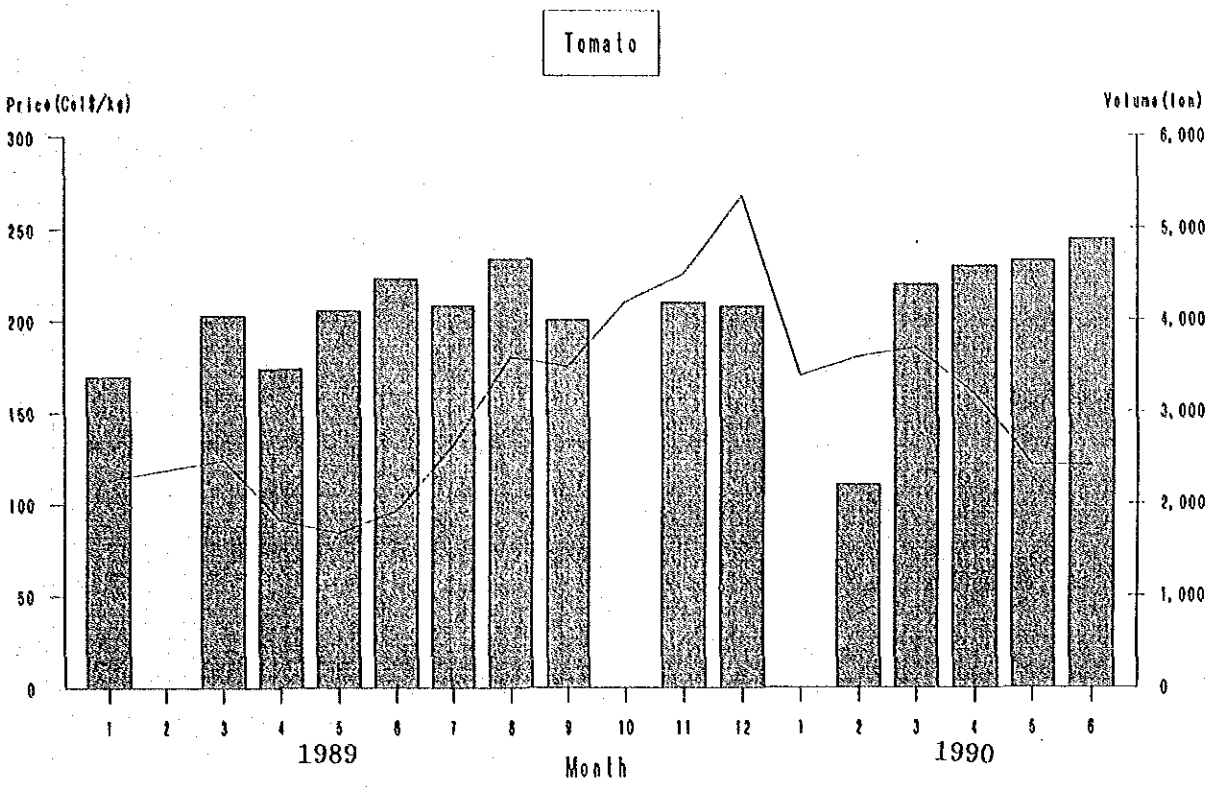


FIG. G.1.2 COLOMBIAN COFFEE'S PRICE AT INTERNATIONAL MARKET



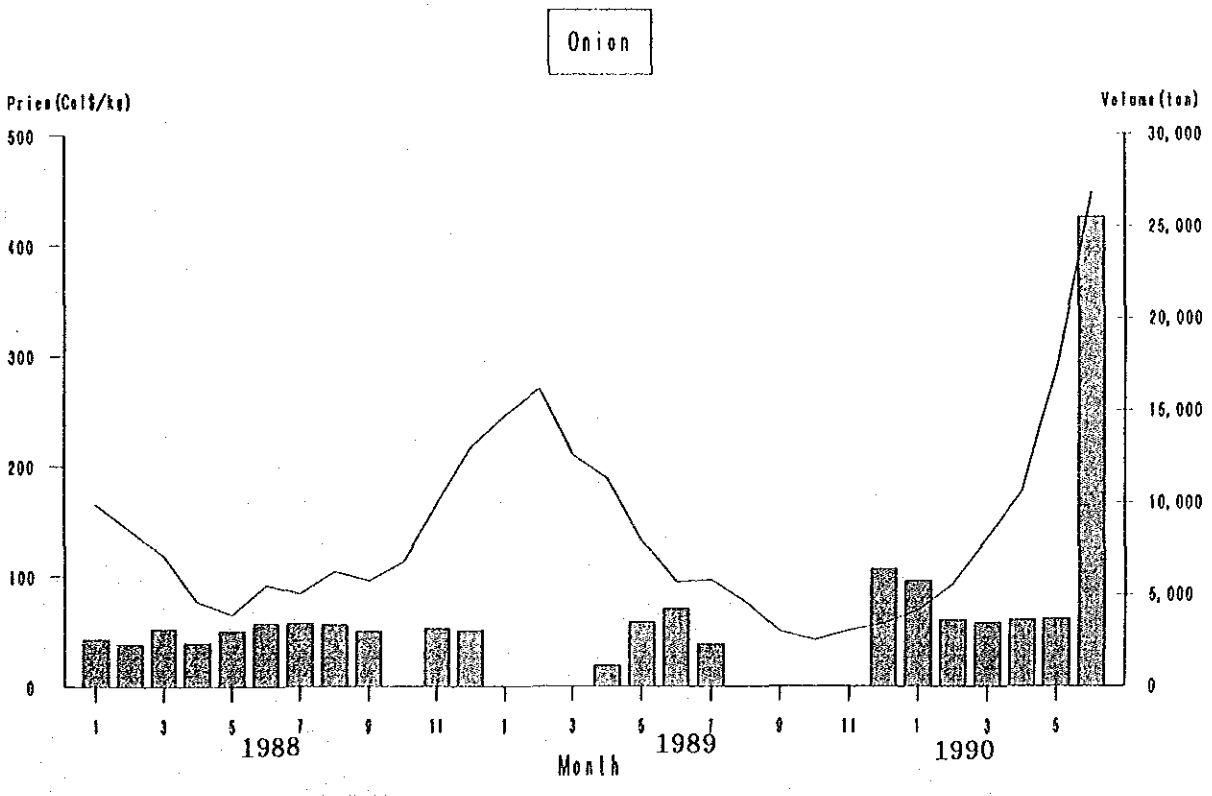
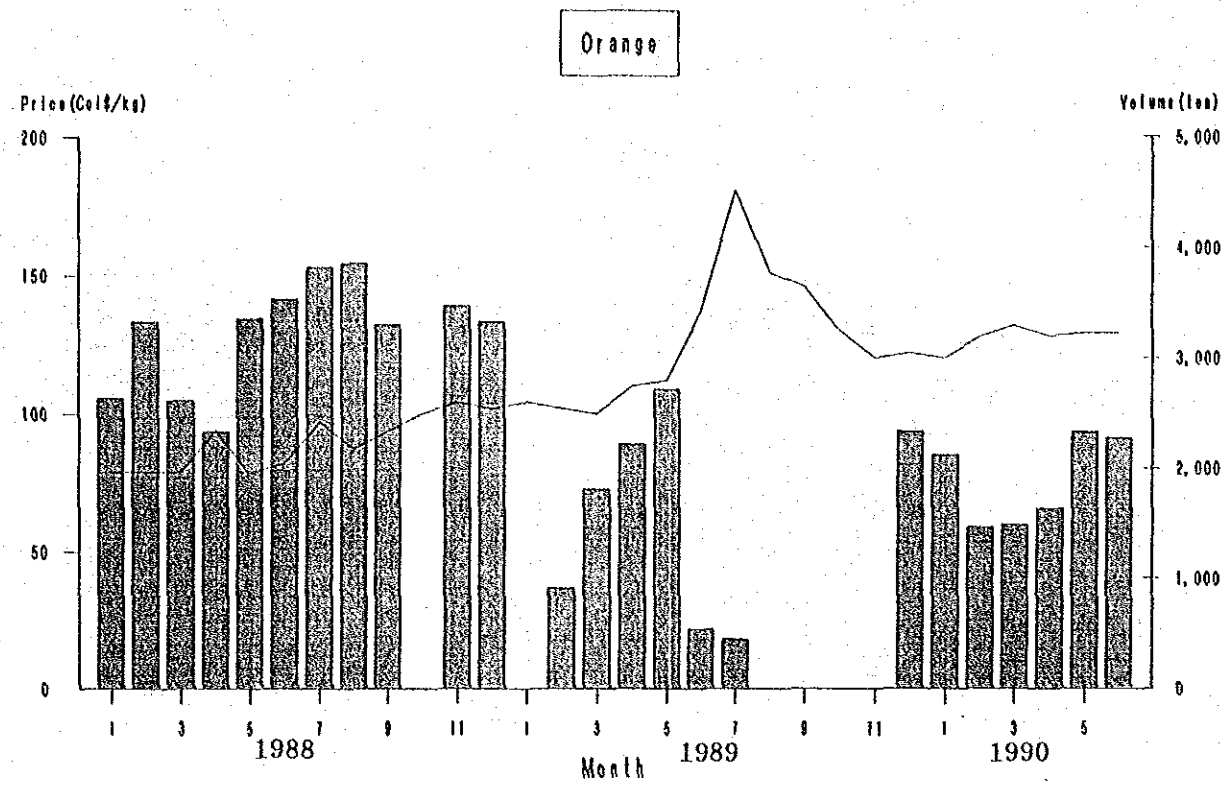


FIG. G.1.3 (1) WHOLESALE PRICE AND VOLUME OF CROP AT CORABASTOS IN BOGOTA



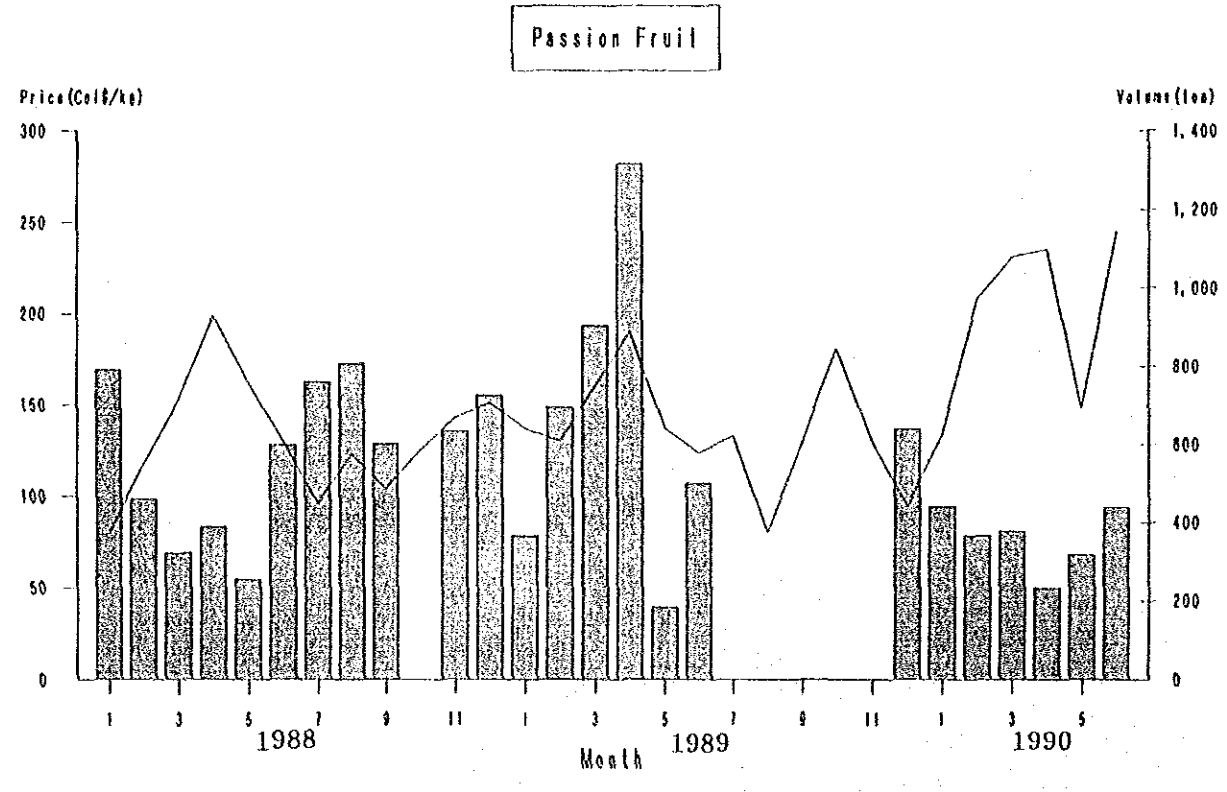
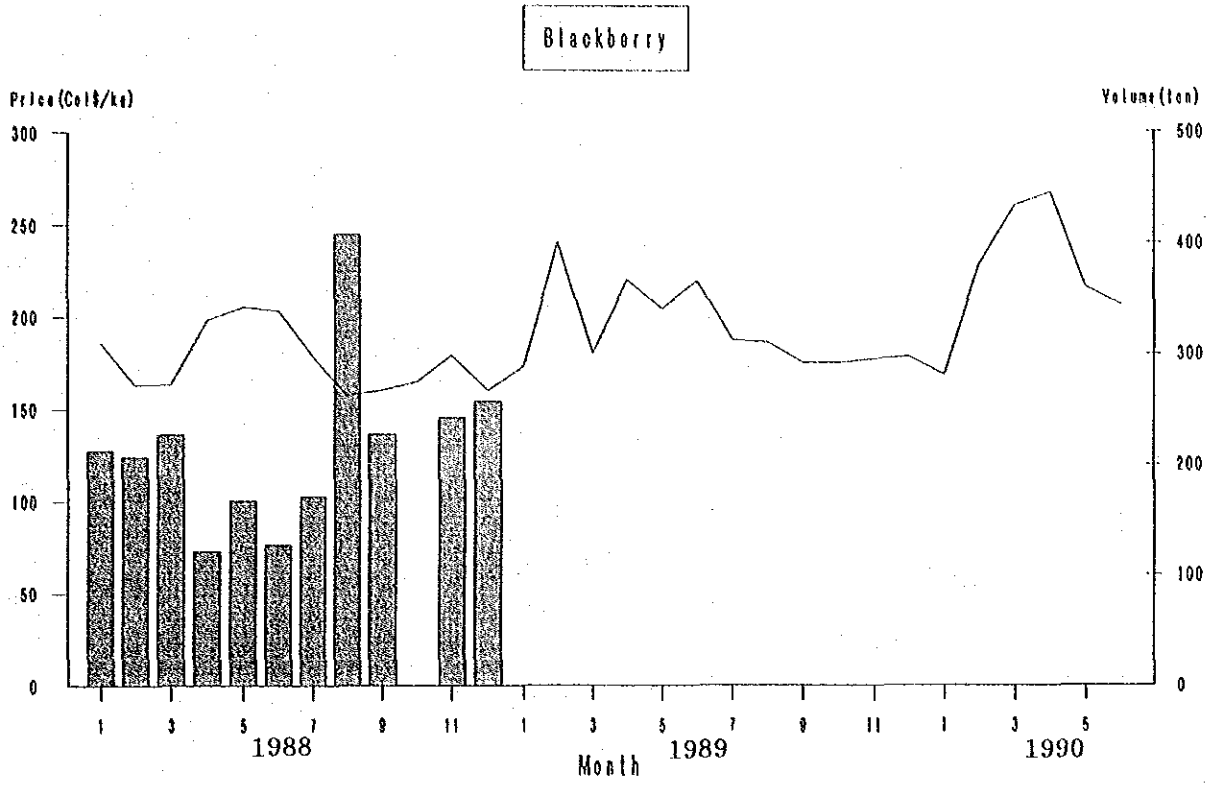


FIG. G.1.3 (2) WHOLESALE PRICE AND VOLUME OF CROP AT CORABASTOS IN BOGOTA



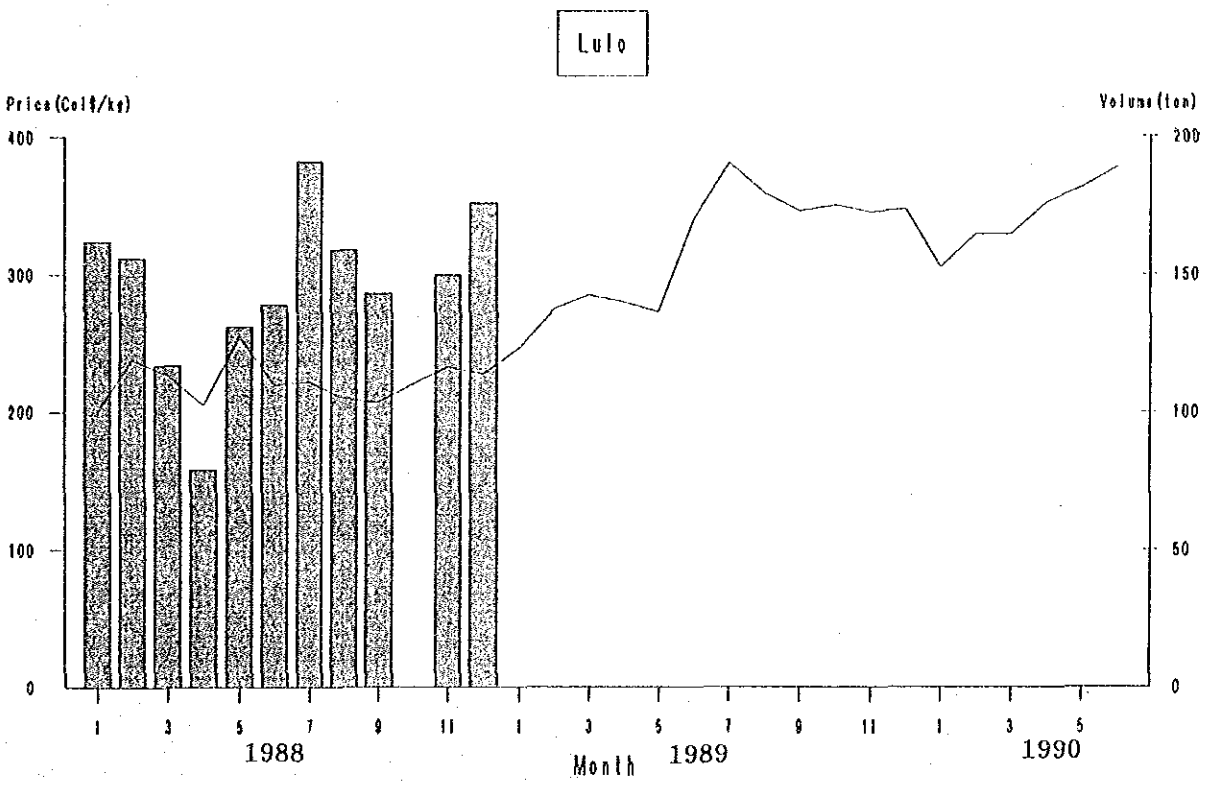
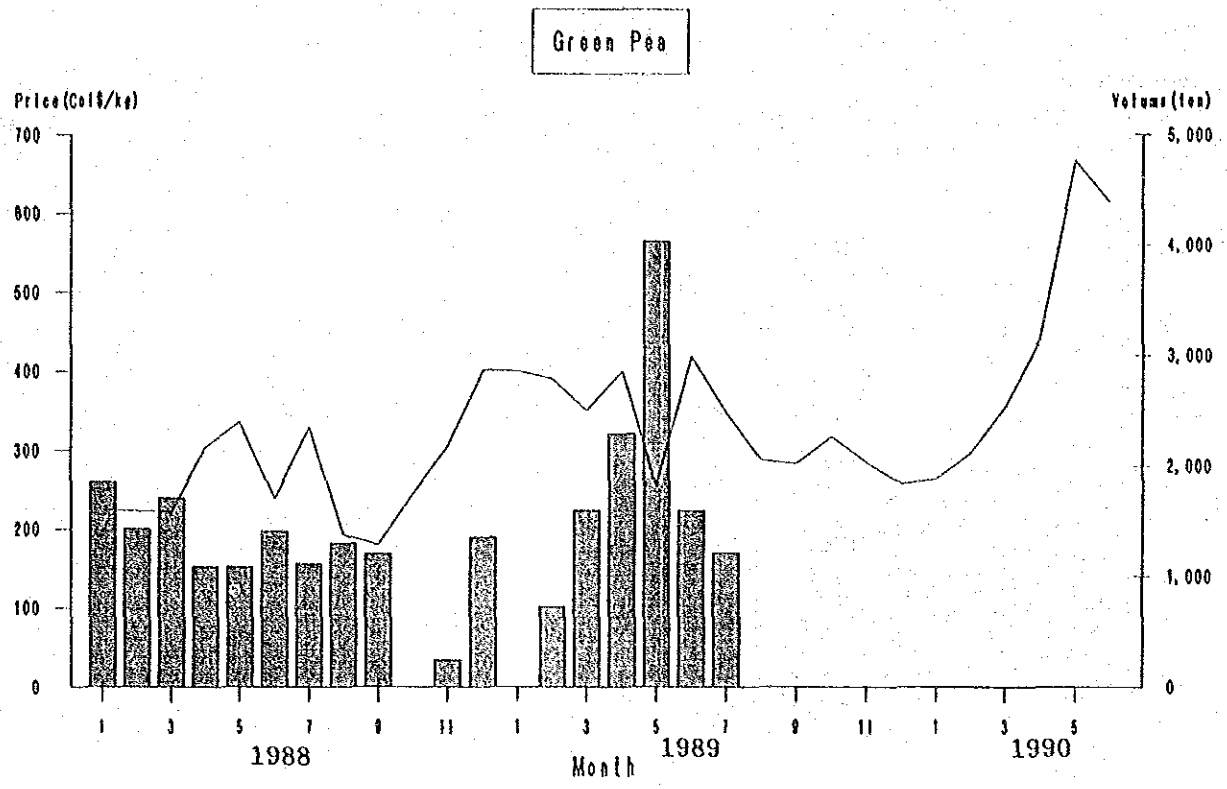


FIG. G.1.3 (3) WHOLESALE PRICE AND VOLUME OF CROP AT CORABASTOS IN BOGOTA



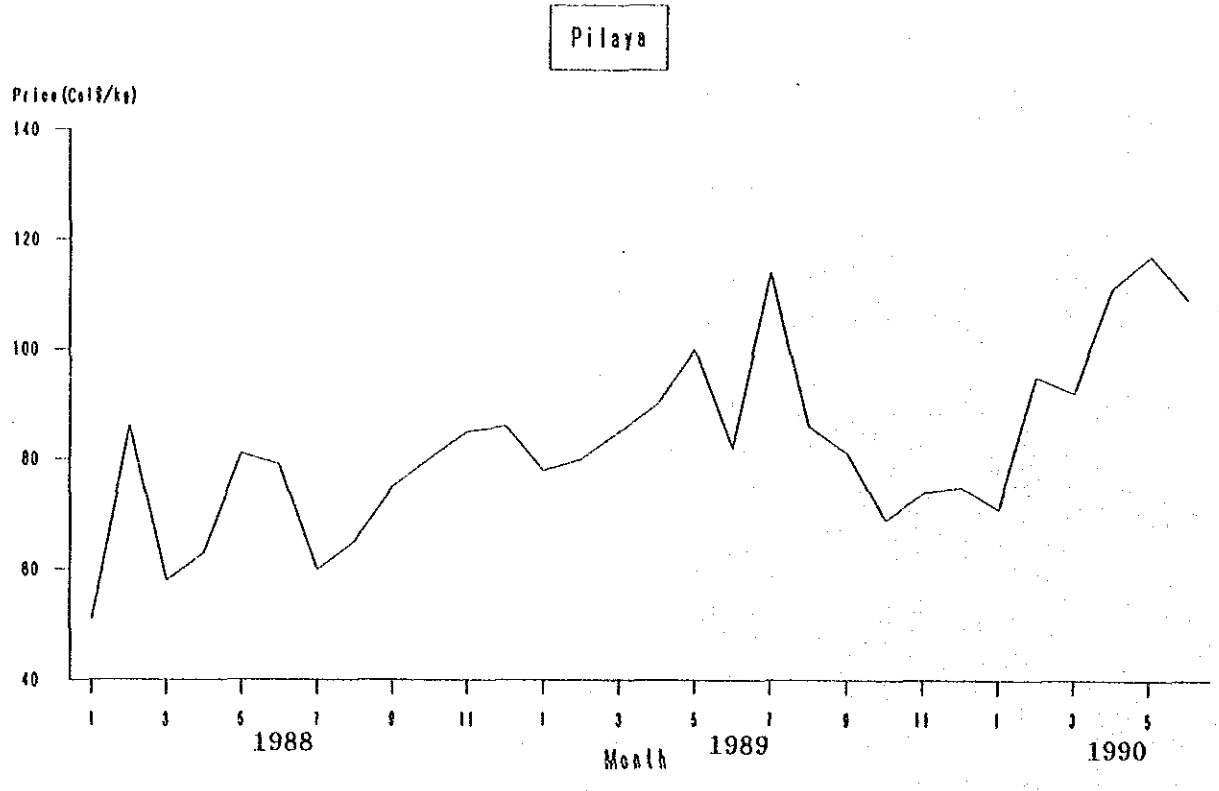


FIG. G.1.3 (4) WHOLESALE PRICE AND VOLUME OF CROP AT CORABASTOS IN BOGOTA

TABLE G.1.1 PURCHASED VOLUME OF PERISHABLE CROPS BY A SUPERMARKET
(MAR. 19-SEP. 23 1990)

CROPS	VOLUME (TON)	REGION(S) PRODUCED
1. Potato (Pastoso)	17,420	Bogota (Corabastos), Narino
2. Potato (Salento)	16,640	Quindio
3. Tomato	12,726	Quindio
4. Onion	9,668	Bogota (Corabastos)
5. Carrot	7,761	Bogota (Corabastos)
6. Welsh Onion	6,612	Rizaralda (Pereira)
7. Banana	6,288	Quindio
8. Potato (Native)	6,245	Bogota (Corabastos)
9. Pineapple	6,078	Rizaralda, Valle
10. Lettuce	5,943	Bogota (Corabastos)
11. Plantain (Green)	5,523	Quindio
12. Cassava	5,410	Quindio
13. Plantain (Matured)	5,111	Quindio
14. Cabbage	4,910	Bogota (Corabastos), Quindio
15. Papaya	4,491	Quindio
16. Mandarin	4,130	Quindio
17. Orange (Valencia)	4,091	Quindio
18. Orange (Tangeno)	3,662	Quindio
19. Arracacha	3,369	Tolima (Cajamarca)
20. Big Tomato	3,356	Quindio
21. Lulo	3,351	Quindio, Valle
22. Passion Fruit	3,330	Quindio, Valle
23. String Bean	3,210	Quindio
24. Tree Tomato	3,180	Quindio
25. Green Pea	3,037	Tolima (Cajamarca), Bogota
26. Mango	2,919	Tolima
27. Big Mango	2,729	Tolima
28. Corn Cob	2,727	Bogota (Corabastos)
29. Lemon	2,572	Quindio

TABLE G.1.2 EXPORT OF COFFEE IN QUINDIO

Unit: FOB US$ x 1000

Year	Export of Coffee		(a)/(b)x100	Total exports	(a)/(c)x100
	Quindio-(a)	Colombia-(b)		in Quindio-(c)	
1984	8,380	1,764,503	0.47	8,462	99.03
1985	23,506	1,745,521	1.35	23,948	98.15
1986	53,215	2,990,530	1.78	53,740	99.02
1987	86,317	1,650,648	5.23	86,819	99.42
1988	19,024	1,640,656	1.16	19,557	97.27

Source: QUINDIO ESTADISTICO 1988
ANUARIO ESTADISTICAS DEL SECTOR AGROPECUARIO 1989

TABLE G.1.3 EVOLUCION OF COLOMBIAN COFFEE'S PRICE AT INTERNATIONAL MARKET

Year/month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dic.	Max.	Min.	Ave.
1981	129.98	127.11	127.93	130.20	127.92	113.94	122.01	126.09	128.02	139.10	146.26	144.17	146.26	113.94	130.23
1982	146.18	156.43	148.04	143.63	139.59	142.63	135.51	134.94	138.27	142.41	140.12	136.85	156.43	134.94	142.05
1983	131.96	128.93	127.04	126.76	130.47	129.33	130.34	131.54	134.31	142.73	146.55	148.66	148.66	126.76	134.05
1984	145.71	147.91	150.32	152.21	152.25	149.30	146.11	147.70	144.23	138.87	142.21	142.80	152.25	138.87	146.64
1985	147.39	146.08	143.88	143.47	144.69	143.89	137.07	135.48	135.48	142.51	157.65	198.95	198.95	135.48	148.05
1986	239.87	230.19	241.60	228.04	213.34	179.08	174.31	175.86	201.50	179.59	158.69	138.23	241.60	138.23	196.69
1987	125.53	122.96	105.77	109.55	119.30	107.12	101.90	104.19	112.52	123.84	130.10	130.40	130.40	101.90	116.10
1988	131.54	142.96	141.70	141.88	142.86	150.14	148.37	136.67	141.73	140.10	142.34	154.94	154.94	131.54	142.94
1989	164.31	150.76	150.19	153.03	151.14	132.72	96.16	82.72	84.18	74.78	76.27	77.54	164.31	74.78	116.15
1990	81.62	87.54	99.66	100.07	98.53	95.69	91.68	99.92	101.85				101.85	81.62	95.17

TABLE G.1.4 COMPARISON OF INTERNATIONAL AND DOMESTIC PRICES OF COFFEE

YEAR	INTERNATIONAL PRICE			DOMESTIC PRICE				AVR. EXCHANGE RATE	EQUIV. US$/KG	INT'l/ DOMESTIC
				CURRENT PRICE		CONSUMER PRICE INDEX	CONSTANT PRICE			
	US$/POUND (1)	US$/KG	INDEX (1985=100)	COL$/125KG	COL$/KG	(1985=100)	(1985=100)			
1981	1.30	2.87	0.88	9,453	75.62	46.44	69	54.49	1.39	2.07
1982	1.42	3.13	0.96	11,171	89.37	57.85	75	64.09	1.39	2.25
1983	1.34	2.95	0.91	13,010	104.08	69.28	75	78.86	1.32	2.24
1984	1.46	3.22	0.99	15,429	123.43	80.47	88	100.82	1.22	2.63
1985	1.48	3.26	1.00	19,509	156.07	100.00	100	142.31	1.10	2.98
1986	1.96	4.32	1.32	37,510	300.08	118.64	94	194.26	1.54	2.80
1987	1.16	2.56	0.78	41,708	333.66	146.30	63	242.61	1.38	1.86
1988	1.43	3.15	0.97	49,551	396.41	187.41	80	299.17	1.33	2.38
1989	1.16	2.56	0.78	62,373	498.98	257.44	66	382.57	1.30	1.96
1990	0.95	2.09	0.64	69,042	552.34	275.10	58	451.73	1.22	1.71

Note: (1) Colombian Mild Coffee at New York market

Source: Division Estadistica, Fedecafe
Revista del Banco de la Republica

TABLE G.1.5 SUPPORTING PRICE OF GRAINS

Crops		1986		1987		1988		1989		1990		1991
		A	B	A	B	A	B	A	B	A	B	A
Kidneybeans	Price	165000	181000	181000	190000	218500	270000	335000	390000	450000	505000	505000
	Index(88B=100)	61.1	67.0	67.0	70.4	80.9	100.0	124.1	144.4	166.7	187.0	187.0
Maize	Price	40500	43700	46760	51000	57000	65500	82000	87800	100500	114600	114600
	Index(88B=100)	61.8	66.7	71.4	77.9	87.0	100.0	125.2	134.0	153.4	175.0	175.0
Sorghum	Price	31500	34000	38500	43200	46200	58000	72200	80000	89600	101000	104000
	Index(88B=100)	54.3	58.6	66.4	74.5	79.7	100.0	124.5	137.9	154.5	174.1	179.3
Soybean	Price	67000	71200	74760	83500	94000	125000	162000	178000	190000	210000	216000
	Index(88B=100)	53.6	57.0	59.8	66.8	75.2	100.0	129.6	142.4	152.0	168.0	172.8
Consumer's Price Index (88.12=100)		57.3	62.9	72.6	78.1	93.2	100	115.2	n.a.	148.5	n.a.	n.a.

Source: Anuario Estadisticas del Sector Agropecuario 1989
Revista del Banco de la Republica, Junio 1990

G.2 MARKETING INFRASTRUCTURE AND AGRO-INDUSTRY

G.2.1 Existing Infrastructure

No substantial marketing and processing facilities is found within the study area. Coffee produced in the study area are processed at threshing factories to distribute for both international and domestic markets. In Armenia, there are two milling factories of coffee, but they don't have enough capacity to process the whole coffee beans produced in Quindio. It is said that about half of milled coffee retailed in Armenia are processed out of Quindio.

Excepting those consumed locally, plantain are collected at market (Plaza del Retiro) in Armenia for distributing the product to wholesale markets of Bogota and the country's other major consumption center.

Having no wholesale nor collecting market for agro-products but plantain within the Department, cassava, orange and other products which are consumed finally out of the Department are transported by intermediaries to wholesale markets of respective region. Crops which are consumed locally are either retailed where they are produced or distributed to two retailing markets (Galeria Central and Plaza Gabriel Mejia) located in Armenia.

Apart from coffee threshing and milling factories, there are some examples of agro-industry which consist of: powder production plant of plantain and cassava, factories to manufacture sweets, animal feed, herb tea and brown sugar, mushroom culture factory, etc., but all of these facilities are small in scale. General description of agro-industry in Quindio is given in Table G.2.1.

There is one pork meat processing factory to produce ham, sausage and other related products, but these products are manufactured only once a week due to insufficient supply of raw materials (more than half of them are provided from departments other than

Quindio). Furthermore, three (two in Armenia and one in Calarca) dairy products processing plants are located in Quindio, but these plants' capacity do not meet to process the total volume of milk produced in the region. Consequently, one-third of the regional output of milk are processed in other departments (the majority are in Risaralda).

G.2.2 Marketing Infrastructure and Agro-industry Development Plans by Concerned Agencies

Leaders and directors in the Department of Quindio have agreed that the critical factor to attain further development of the agricultural sector as well as the regional economy is to facilitate an improvement and development of agro-products marketing system and agro-industry, and in this connection various policies and measures have been taken for that purpose. The faculty of agro-industry was created at the University of La Gran Colombia where students are educated technical and managerial expertise of agro-industry and related subjects. On the other hand, various feasibility and similar type of studies have been conducted by Promocaldas (financing institute for industrial and agricultural developments projects implemented in departments of Quindio, Caldas and Risaralda) to assess the development of agro-industry in Quindio. In addition, in pursuance of an integration of policies and strategies at the regional level together with promoting development of agro-industry , the "Agro-industry Promotion Committee" has been established with a participation of universities of La gran Colombia and Quindio and public and quasi-governmental institutions concerned with agricultural and agro-industrial sectors. As an initial step of the activity, the Committee is expected to elaborate an agro-industry development plan for the Department of quindio setting the target year of the plan as 2005.

At present, two important projects of the sector are being

implemented or projected in Quindio.

(1) Citrus transformation plant

The project, which is implemented by Cicolsa (Citrus Colombia Co., Ltd), envisages to transform fresh fruits of citrus into concentrated juice. Raw materials for the project are expected to be supplied from four departments of Quindio, Caldas, Risaralda, and Valle; with implementation of promotion program under the diversification plan conducted by the Coffee Committee, it is forecasted that the cultivated area of citrus in the said four department would be expanded in double from 4,200 ha to 8,400 ha.

The plant is under construction at present and its operation will start in June 1991. Concentrated fruits juice to be produced at the plant shall be traded to Meal S.A.-one of shareholders of the company. Equipment of the plant are designed to process both orange and passion fruits at the rate of 7.5 t/hr. for the former and 4.0 t/hr. for the latter both calculated on the basis of fresh fruits.

(2) Wholesale market of Armenia

The executing agency of the project is Mercar S.A. which is formed with a participation of the public sector consists of Departmental Office of Quindio, Municipal Office of Armenia, Coffee Committee and Public Enterprise of Armenia, and the private sector represented by wholesalers. The nuclear objective of the project is to develop and improve at wholesale level. At the initial stage of the project, it is proposed to cover the city of Armenia and its influence range, and later on to expand the marketing channel to other regions so as to establish nation-wide marketing network. The location of the wholesale market is projected on the outskirts of Armenia. A total of eight warehouses are designed in the market to be constructed in two phases. Warehouses are divided in the following categories:

- Two warehouses for plantain, cassava and orange: about 850 t/week
- Two warehouse for fruits, vegetables, meat and eggs: about 655 t/week
- Four warehouses for grains and processed products: 825 t/week

The total investment cost of the project is estimated to be US$ 5,000 thousand at 1990's market price. Actually, the project seeks for financing agency through F.F.D.U (Financing Fund for Urban Development); some portion of the investment is covered by this fund and contact with other public and private agencies interested in investment for the remaining cost is in progress.

Besides, promotion for development of agro-industry is conducted by Promocaldas (Cooling and refrigerating plant for milk and transformation plant of tomato) and Proexpo (production and processing of non-traditional products oriented to international market).

TABLE G.2.1 EXISTING AGRO-INDUSTRY IN QUINDIO

Processed Products	Armenia		Calarca		La Tebaida		Filandia		Montenegro		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Meat Processing	1	100									1	2.5
Milk	1	100									1	2.5
Cheese, Butter	1	50	1	50					1	50	2	5
Seasoning	1	100									1	2.5
Cake	1	50									2	5
Milling					2	100					2	5
Ice Cream	5	100									5	12.5
Coffee Roast	2	100									2	5
Potato Chips	3	100									3	7.5
Assorted Animal Feed	1	50			1	50					2	5
Leather	3	17.6	14	82.4							17	42.5
Herb Tea							1	100			1	2.5
Mashroom							1	100			1	2.5
Total	19	47.5	15	37.5	3	7.5	2	5	1	2.5	40	100

Source: Promocaldas

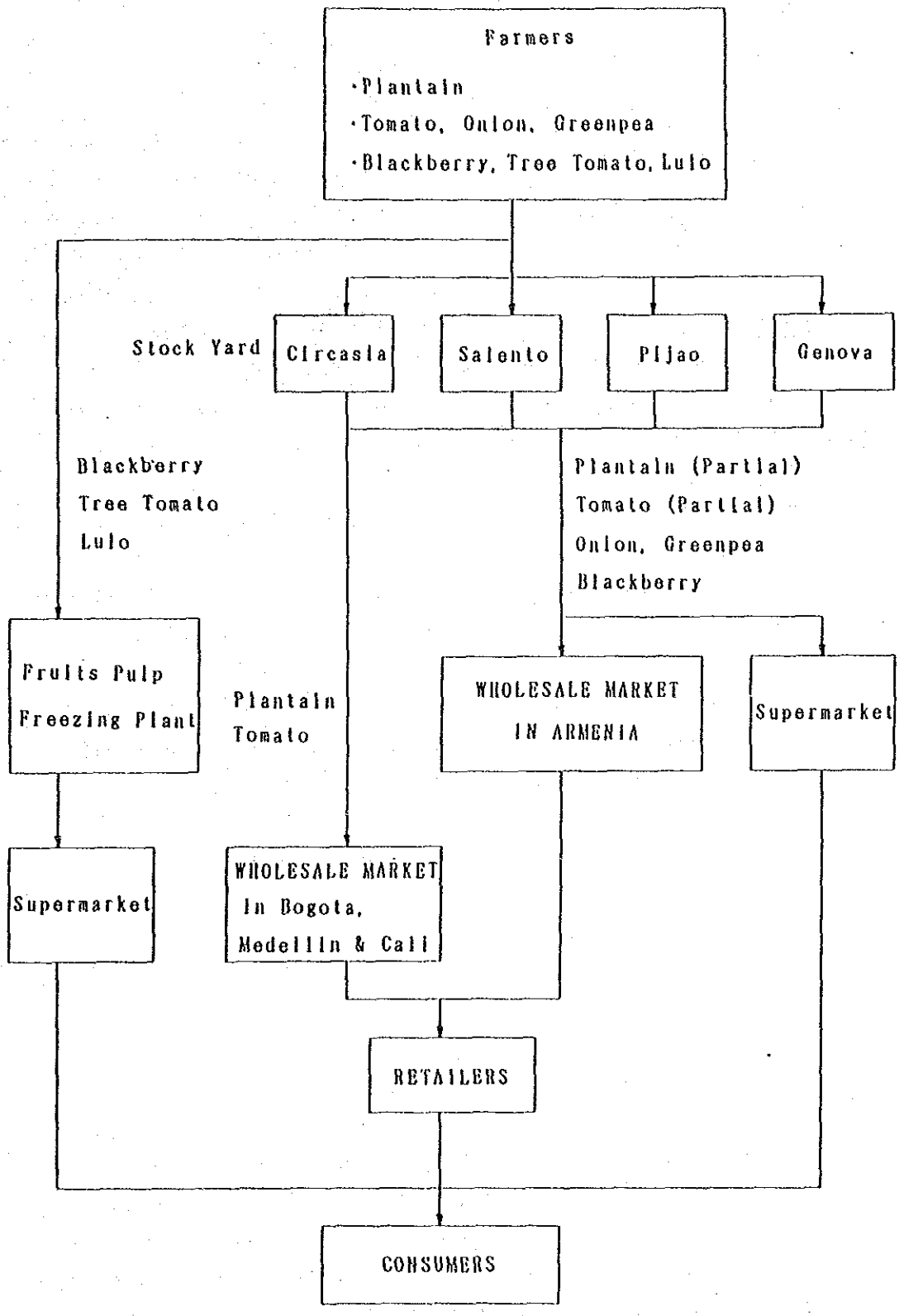


FIG. G.2.1 FLOW CHART FOR MARKETING OF VEGETABLES AND FRUITS

G.3 MARKETING AND AGRO-INDUSTRY DEVELOPMENT PLAN

G.3.1 Principles for Formulation of the Plan

Except for coffee, no agro-product produced in the Department of Quindio is traded through secured marketing channel, that has constituted one of constraints on realization of diversified farming activities. Although there are some products such as cassava, plantain, orange and tomato which are marketed outside the department and highly appreciated by consumers there, their marketing channel from producers to wholesale markets is far from being appropriate. These unfavorable marketing circumstances have been against producers' interest.

On the other part, an agroindustry in Quindio has been under-developed up to date despite raw materials for the industry are sufficiently produced within the region, which is correlated with dull performance of the regional economic activities.

The above cited situation is well understood by leaders of the department, thus various plans and programs have been proposed. Examples of these plans and programs are listed below:

1. Establishment of Agroindustry Promotion Committee

2. Diversification Plan of Coffee Committee

3. Armenia Wholesale Market Construction Plan

4. Cooperative Re-construction Plan

Of the said plans and programs, nos. 1 and 2 are in progress now, while nos. 3 and 4 are prepared their feasibility study and financing arrangement for their implementation tried. Because these plans and programs are directly or indirectly concerned with the present project, due consideration shall be made on them in

formulating marketing and agroindustry development plan.

G.3.2 Marketing Plan

(1) Marketing system

Save for those consumed locally-plantain, cassava and kidney bean, the great majority of agro-products shall be traded outside the project area represented by Armenia and other big markets such as Bogota, Medellin and Cali. Passion fruits shall be destined for international markets after being transformed at factories, and other fruits composed of tree tomato, blackberry and lulo shall be assessed their possibility for export.

As discussed above, most of commodities to be produced in the project area shall be traded at markets outside the project area, no marketing facilities but for collecting and storage yards to be located between farmers and wholesale markets shall be taken into account in this project.

Marketing forecast for crops and livestock products is described hereinunder. Being established firmly from growers to loading port for export, it is considered further development of marketing channel for coffee is unnecessary within this project. Up to date, coffee growers have been supported by the government of Colombia in relation with production and marketing of their products, because coffee has been contributed greatly to foreign exchange earning of the country. Nevertheless, due to continuously depressed international prices, it is of doubt that coffee growers will be treated in the future as favorably as they are at present.

With the implementation of the project cultivated area of coffee will be reduced due to shifting of its area covered by traditional varieties to other crops. The drop in production associated with reduced cultivated will account for as few as 0.7% of the departmental production (1989), thus this shrinkage shall be

negligible within the context of the economic performance of the Department of Quindio.

Plantain and cassava are staple foodstuff for the Colombian diet and their demand is consistent. With high reputation in the country's major markets such as Bogota, Medellin and Cali, it will be no need for apprehension in terms of marketing them, although an improvement of the marketing channel between farmers and wholesale markets is expected-an excessive intervention of intermediaries has been disadvantageous for farmers. Cooperative marketing by means of farmers organization shall be proposal for improvement.

An expansion of cultivated area for citrus is envisaged within the diversification plan promoted by the Coffee Committee and, as a part of the said plan, an incorporation of a processing plant is included. Under the circumstances, citrus to be produced in the project area shall be brought to this processing plant. Passion fruits are getting into the spotlight as non-traditional export-oriented commodities with better marketing conditions. As a destination of the fruits existing concentrated juice production plants in the departments of Caldas and Valle as well as newly constructed plant of the Cicolsa shall be proposed.

Pitaya, the origin of which is in Colombia, has become appreciated highly in both national and international markets owing to its mild and refreshing taste; especially in the latter market, this fruit is prosperous without competitive countries. It is regretful though that sanitary problem has taken place resulting in being shutout recently in the external markets. Immediate measures to relax this constrain is required.

Soybean-related commodities are one of major imports in Colombia, so an increase in its production is encouraged by the Ministry of Agriculture; according to " Selective Supply Plan" formulated at

the time of the Barco Administration, it was targeted to attain the self-sufficiency of the grain by 1995 and for this target its cultivated area needed to be triplicated. Soybean shall be traded to oil manufacturing plants in Valle as it is done actually. Sorghum is an important crop to feed animals with high and consistent demand. The same marketing channel as soybean shall be considered.

Tomato may be the only vegetables which has a market in addition to the local market in Quindio. The crop is sold to wholesale markets in Bogota, Medellin etc. Relative to other crops, higher net returns are expected, but seasonable imbalance between supply and demand affects the profitability of the product. In this context, it is recommended to form organization of its growers as that efficient marketing might be made and up-to-date and wide ranged marketing information might be collected.

Within Quindio, onions and green peas are not cultivated commercially and their consumption by local population is satisfied with supply from the Corabasto in Bogota and Cajamarca in Tolima. Therefore these vegetables to be produced in the project area shall be traded within Quindio, mainly in Armenia. As the case of tomato, organization of farmers shall be critical for better marketing.

Some portion of the production for kidney bean and maize shall be left for consumption of farmers and farm workers, and the rest shall be sold to local markets or to markets in Armenia.

Presently, blackberries, lulos and tree tomatoes are sold within the department, because their output is very few, although their processed (frozen pulps) products have a market in Bogota. This project envisages a drastic expansion of these fruits, and as for their marketing, the following may be proposed.

1. By producing high quality products and with an Individual Quick

Freezing method, to export to European countries and other markets.

2. To freeze their pulps within the department and to market processed products to Bogota, Medellin, Cali and other country's major markets.

3. To trade fresh fruits.

It is advisable that for the time being the latter two proposals should be practiced, then the former proposal should be studied its feasibility for implementation. In any proposal, these products are to be undertaken by medium and small farmers, so success in marketing shall only be attained with organizing them.

(2) Marketing infrastructure

As discussed in the previous sub-section (1), an organization of farmers is proposed in respect with marketing of plantain, tomato, onion, green pea, blackberry, lulo, and tree tomato in view that:

1. Most of growers for these crops will be medium and small farmers

2. At present, marketing of these crops is constrained from an absence of established channels.

A proposed marketing channel for the said crops is as illustrated in Fig. G.2.1.

As this diagram shows, collection and storage yards administrated and operated by cooperatives shall be established in respective municipality of Circasia, Salento, Pijao and Genova, and products are to be traded to wholesale markets or supermarkets located in Armemia, Bogota, etc. through this channel. Outline of these collection and storage yard is given in Annex E.

G.3.3 Agro-industry Development Plan

(1) Development principle

Bearing in mind that the quantity if agro-products other than coffee in the area is limited, it is not feasible to develop large scaled agroindustru within the project area. Even if to expect supply of raw materials outside the project area, the geographical condition, accessibility, availability of qualifies labor force and the like shall constitute bottle neck for development of agroindustry in the project area. It is therefore recommended to develop small and medium installations to process agriculture-related raw materials.

Advantageous aspects to develop these small and medium enterprises are:

- To require relatively low amount of investment.
- By and large, more job opportunity is expected in comparison with the capacity of production.
- Sometimes it is possible to install a plant within farms or in isolated rural areas.
- Technology is not complicated and administration is simple.
- Full operation of plants can be accomplished in shorter time.

(2) Plants installation plan

Plants for freezing pulps extracted from fruits of blackberry, tree tomato, and lulo shall be installed in Circasia (two), Salento, Pijao and Genova.

General specification of proposed plant is as follows:

Boiling tank: 190 l
Pulp extraction capacity: 100-150 kg/hr.
Packing: 420 bags/hr.
Regrigerating unit: 7 m3
Freezing unit: 5 m3

The cost for installation of a plant is estimated to be Col$ 6,700,000, thus the total cost shall be Col$ 33,500,000 covering five plants.

ANNEX H :

IRRIGATION AND DRAINAGE

ANNEX H : IRRIGATION AND DRAINAGE

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H.1 IRRIGATION PLAN

H.1.1 General

1,600 mm - 2,800 mm of annual rainfall can be expected in the study area, therefore irrigation system is not always required through the year under the existing agriculture management system. However, it wood be possible to improve agricultural management, introducing irrigation system. Through verbal investigations, it was found out that the time for seeding is determined with consideration to the rainfall expected, and it is one of the restrictions to the cropping pattern. In the Study area a few farmers have irrigation system with sprinklers, and they irrigate the crops (coffee, vegetables, pasture, etc.) in the dry season when there is no rainfall for two or three weeks. The undulating topographic condition with exception of some lower land in Quindio constitute one of constraints on the installation of irrigation system. Also the improvement of agricultural workbility is hindered by such topographical condition. Therefore, it would be necessary to study the installation of sprinkler system with aims not only at irrigation, but also at fertilization, disease and pest control and etc; i.e. a multi-purpose irrigation system.

H.1.2 Water Requirements

Water requirements are calculated following manner;

(a) Calculation of Potential Evapotranspilation
(b) Calculation of Crop Water Requirements
(c) Calculation of Irrigation Water Requirements

From the monthly calculation, the almost enough effective rainfall can be expected in the study area. However, more than 10 days of continuous drought day can also be expected every year. Therefore, an irrigation plan will be made in consideration of monthly effective rainfall, and an irrigation system will be designed based

on the peak water requirement.

(1) Potential Evapotranspiration

Due to lack of meteorological information (evaporation, wind velocity, etc.), it is difficult to estimate evapotranspiration volume by applying the Penman method which is recommended by HIMAT. Consequently, estimation was made, by Garcia Lopez method there results similar to Penman can be acquired for areas from 1,000 m to 2,000 m at altitude.

$$ETP=1.21*10^{n}*(1-0.01*HR)+0.21*T-2.30$$

where ETP : Potential Evapotranspiration (mm)
HR : Humidity (%)
T : Temperature (C)
n : Coefficient n=7.45*T/(234.7+T)

The results of estimation for the study area are shown in Table H.1.1 and summarized below:

Circasia area	:	690 mm/year
Salento area	:	980 mm/year
Quindio right area	:	1,220 mm/year
Quindio left area (1),(2)	:	1,250 mm/year
Pijao area	:	960 mm/year
Genova area	:	970 mm/year

(2) Crop Water Requirements

In accordance with the "Guideline for Predicating Crop Water Requirements (FAO 1977)" and field investigations, the crop water requirements were estimated. Based on the proposed cropping pattern, the crop coefficient of development stage for each crop has been estimated as shown in Table H.1.2 and the monthly crop water requirements were calculated.

ETC=Kc*ETP

where ETC : Crop Water Requirement (mm/month)
Kc : Crop Coefficient
ETP : Evapotranspiration (mm/month)

The results are shown in Table H.1.2.

(3) Irrigation Water Requirements

Considering the proposed irrigation area, the peak water requirements for each study area were estimated.

PWR=ETC*A*10/86400/D

where PWR : Peak Water Requirement (m3/s)
A : Cropping Area (ha)
D : Days in a Month

Considering effective rainfall, the mean water requirements are calculated as follows;

MWR=(ETC-ER)*A*10/86400/D

where MWR : Mean Water Requirement (m3/s)
ER : Effective Rainfall (mm/month)

These PWR and MWR mentioned above equal the net water requirements for irrigation. And gross water requirements cold irrigation water requirements ware calculated in consideration of the following irrigation efficiency;

Conveyance Efficiency (Ec) 0.95
Field Canal Efficiency (Eb) 0.95
Field Application Efficiency (Ea) 0.75
Total Irrigation Efficiency (Ei) 0.95*0.95*0.75=0.68

PWQ=PWR/Ei

MWQ=MWR/Ei

where PWQ : Peak Irrigation Water Requirements (m3/s)

MWQ : Mean Irrigation Water Requirements (m3/s)

PWQ and MWQ were estimated as shown in Table H.1.3.

The irrigation efficiency was estimated on the basis of FAO' guideline and taking into account of physical conditions of the study area and previous records. Intake rate was tested at 8 points as shown in Fig.H.1.1 and the result is shown in Tables H.1.4, H.1.5 and Fig.H.1.2.

(4) Required Catchment Area for Irrigation

Based on the PWQ and the drought water discharge, required catchment area were calculated. 80% of drought discharge was adopted for available discharge for irrigation. The required catchment area is shown in Table H.1.6

Table H.1.1 Ptential Evapotranspiration (Garcia Lopez)

Study Area	Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Circasia	Tm (°C)	15.5	15.2	15.9	15.5	15.1	14.9	15.9	15.8	15.4	14.8	15.0	15.0	15.3
	Hr (%)	71.4	69.8	74.6	72.3	71.5	71.5	76.2	74.8	70.3	69.1	68.6	71.5	71.8
	ETP(mm)	60.7	54.0	60.5	57.8	57.2	53.7	58.7	59.4	59.0	57.1	57.4	56.3	691.8
Salento	Tm (°C)	17.6	18.2	18.4	17.2	19.5	19.3	18.3	18.2	17.8	17.5	17.5	17.5	18.1
	Hr (%)	71.4	69.8	74.6	72.3	71.5	71.5	76.2	74.8	70.3	69.1	68.6	71.5	71.8
	ETP(mm)	78.8	77.8	81.6	74.2	95.5	93.7	78.7	79.7	81.9	80.7	81.4	77.8	981.7
Quindio Right	Tm (°C)	22.2	22.2	22.3	21.8	21.9	21.9	22.2	22.3	21.9	21.3	21.2	21.7	21.9
	Hr (%)	78.0	79.0	78.0	82.0	82.0	81.0	78.0	78.0	79.0	82.0	82.0	81.0	80.0
	ETP(mm)	109.6	97.5	110.4	96.4	100.5	98.8	109.6	110.4	101.9	95.5	91.6	100.4	1,222.6
Quindio Left	Tm (°C)	21.6	21.9	21.9	21.7	21.5	21.6	22.0	22.0	21.5	20.9	21.0	21.3	21.6
	Hr (%)	75.9	74.8	75.8	79.1	80.7	78.9	74.0	74.1	76.8	80.2	80.3	78.4	77.4
	ETP(mm)	107.7	101.3	110.5	103.4	99.2	102.9	114.3	114.2	105.4	95.0	95.6	101.1	1,250.7
Pijao	Tm (°C)	19.0	19.2	18.7	18.6	18.4	18.5	18.5	18.6	17.6	17.8	18.1	18.3	18.4
	Hr (%)	73.0	72.0	72.5	77.0	76.0	76.5	73.5	74.5	75.5	78.5	77.0	75.0	75.1
	ETP(mm)	89.0	83.2	87.0	77.6	79.8	77.4	83.9	83.5	71.3	71.6	73.5	80.3	958.2
Genova	Tm (°C)	19.0	19.2	18.7	18.6	18.4	18.5	18.5	18.6	17.6	17.8	18.1	18.3	18.4
	Hr (%)	73.0	72.0	72.5	77.0	76.0	76.5	73.5	74.5	75.5	78.5	77.0	75.0	75.1
	ETP(mm)	89.0	83.2	87.0	80.2	79.8	80.0	83.9	83.5	73.7	71.6	76.0	80.3	968.2

Note : Tm=Temperature, Hr=Relative Humidity, ETP=Ptential Evapotranspration

Table H.1.2 Crop Water Requirement (1) Circasia

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	ETP(mm)	60.7	54.0	60.5	57.8	57.2	53.7	58.7	59.4	59.0	57.1	57.4	56.3	691.8
Rainfall	R (mm)	215	217	301	315	259	144	96	126	175	415	371	257	2891
	1/2	106	106	108	108	108	99	80	93	103	108	108	107	1234
Effective	1/5	104	104	108	108	106	93	72	87	101	108	108	106	1205
Rainfall	1/10	103	103	106	107	106	90	68	83	98	108	108	106	1186
(mm)	1/20	103	103	106	106	105	87	64	79	95	108	108	105	1169
Annual	Kc	0.66	-	0.53	0.89	1.00	0.98	0.66	-	0.53	0.89	1.00	0.98	-
Crop	ETC (mm)	40.0	-	32.1	51.4	57.2	52.6	38.8	-	31.3	50.8	57.4	55.2	466.7
	1/2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1/5	-	-	-	-	-	-	-	-	-	-	-	-	-
	1/10	-	-	-	-	-	-	-	-	-	-	-	-	-
	1/20	-	-	-	-	-	-	-	-	-	-	-	-	-
Tree Crop	Kc	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	-
	ETC (mm)	54.59	48.62	54.45	51.98	51.44	48.31	52.85	53.50	53.12	51.40	51.70	50.68	622.63
	1/2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1/5	-	-	-	-	-	-	-	-	-	-	-	-	-
	1/10	-	-	-	-	-	-	-	-	-	-	-	-	-
	1/20	-	-	-	-	-	-	-	-	-	-	-	-	-

Table H.1.2 Crop Water Requirement (2) Salento

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	ETP(mm)	78.8	77.8	81.6	74.2	95.5	93.7	78.7	79.7	81.9	80.7	81.4	77.8	981.7
Rainfall	R (mm)	141	194	178	274	199	111	66	71	139	335	307	236	2251
	1/2	98	105	103	108	105	88	59	63	98	108	108	106	1149
Effective	1/5	91	103	101	105	103	80	51	55	91	108	108	105	1101
Rainfall	1/10	88	102	98	106	102	75	48	51	87	108	106	104	1075
(mm)	1/20	85	99	95	105	100	71	45	48	84	106	106	103	1047
Annual	Kc	0.66	-	0.53	0.89	1.00	0.98	0.66	-	0.53	0.89	1.00	0.98	-
Crop	ETC (mm)	52.0	-	43.3	66.0	95.5	91.8	51.9	-	43.4	71.9	81.4	76.2	673.4
	1/2	-	-	-	-	-	3.8	-	-	-	-	-	-	3.8
	1/5	-	-	-	-	-	11.8	0.9	-	-	-	-	-	12.8
	1/10	-	-	-	-	-	16.8	3.9	-	-	-	-	-	20.8
	1/20	-	-	-	-	-	20.8	6.9	-	-	-	-	-	27.8
Tree Crop	Kc	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	-
	ETC (mm)	70.90	70.00	73.48	66.77	85.95	84.33	70.84	71.70	73.72	72.66	73.22	70.00	883.57
	1/2	-	-	-	-	-	-	11.8	8.7	-	-	-	-	20.54
	1/5	-	-	-	-	-	4.3	19.8	16.7	-	-	-	-	40.87
	1/10	-	-	-	-	-	9.3	22.8	20.7	-	-	-	-	52.87
	1/20	-	-	-	-	-	13.3	25.8	23.7	-	-	-	-	62.87

Table H.1.2 Crop Water Requirement (3) Quindio River Right Margin

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	ETP(mm)	109.6	97.5	110.4	96.4	100.5	98.8	109.6	110.4	101.9	95.5	91.6	100.4	1222.6
Rainfall	R (mm)	120	139	177	256	213	135	97	114	169	242	285	151	2098
	1/2	91	97	103	107	106	96	80	89	103	106	108	101	1187
Effective	1/5	82	89	100	106	103	88	70	79	98	105	105	93	1118
Rainfall	1/10	76	85	95	105	103	83	64	73	93	103	106	89	1075
(mm)	1/20	72	80	92	103	100	79	60	69	90	103	105	85	1038
Annual	Kc	0.66	-	0.53	0.89	1.00	0.98	0.66	-	0.53	0.89	1.00	0.98	-
Crop	ETC (mm)	72.3	-	58.5	85.8	100.5	96.8	72.3	-	54.0	85.0	91.6	98.4	815.3
	1/2	-	-	-	-	-	0.8	-	-	-	-	-	-	0.8
	1/5	-	-	-	-	-	8.8	2.3	-	-	-	-	5.4	16.5
	1/10	-	-	-	-	-	13.8	8.3	-	-	-	-	9.4	31.5
	1/20	0.3	-	-	-	0.5	17.8	12.3	-	-	-	-	13.4	44.3
Tree Crop	Kc	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	-
	ETC (mm)	98.6	87.7	99.4	86.8	90.4	88.9	98.6	99.4	91.7	86.0	82.5	90.4	1100.3
	1/2	7.6	-	-	-	-	-	18.6	10.4	-	-	-	-	36.60
	1/5	16.6	-	-	-	-	0.9	28.6	20.4	-	-	-	-	66.51
	1/10	22.6	2.7	4.4	-	-	5.9	34.6	26.4	-	-	-	1.4	97.98
	1/20	26.6	7.7	7.4	-	-	9.9	38.6	30.4	1.7	-	-	5.4	127.72

Table H.1.2 Crop Water Requirement (4) Quindio River Left Margin

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	ETP(mm)	107.7	101.3	110.5	103.4	99.2	102.9	114.3	114.2	105.4	95.0	95.6	101.1	1250.7
Rainfall	R (mm)	135	124	198	280	224	97	67	99	160	299	283	170	2136
	1/2	96	93	105	108	106	81	60	82	103	108	108	103	1153
Effective	1/5	90	86	103	106	105	72	52	73	97	107	106	100	1097
Rainfall	1/10	86	82	102	106	103	68	48	69	93	106	106	96	1065
(mm)	1/20	83	78	100	106	103	64	45	65	91	106	106	93	1040
Annual	Kc	0.66	-	0.53	0.89	1.00	0.98	0.66	-	0.53	0.89	1.00	0.98	-
Crop	ETC (mm)	71.1	-	58.6	92.1	99.2	100.9	75.5	-	55.9	84.5	95.6	99.1	832.4
	1/2	-	-	-	-	-	19.9	15.5	-	-	-	-	-	35.3
	1/5	-	-	-	-	-	28.9	23.5	-	-	-	-	-	52.3
	1/10	-	-	-	-	-	32.9	27.5	-	-	-	-	3.1	63.4
	1/20	-	-	-	-	-	36.9	30.5	-	-	-	-	6.1	73.4
Tree Crop	Kc	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	-
	ETC (mm)	96.9	91.2	99.5	93.1	89.3	92.6	102.9	102.8	94.8	85.5	86.1	91.0	1125.6
	1/2	0.9	-	-	-	-	11.6	42.9	20.8	-	-	-	-	76.21
	1/5	6.9	5.2	-	-	-	20.6	50.9	29.8	-	-	-	-	113.37
	1/10	10.9	9.2	-	-	-	24.6	54.9	33.8	1.8	-	-	-	135.21
	1/20	13.9	13.2	-	-	-	28.6	57.9	37.8	3.8	-	-	-	155.21

Table H.1.2 Crop Water Requirement (5) Pijao

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	ETP(mm)	89.0	83.2	87.0	77.6	79.8	77.4	83.9	83.5	71.3	71.6	73.5	80.3	958.2
Rainfall	R (mm)	183	183	186	264	194	97	79	93	136	314	311	231	2271
	1/2	104	104	104	108	105	81	69	78	97	108	108	105	1171
Effective	1/5	102	102	103	105	103	72	61	70	90	108	108	105	1129
Rainfall	1/10	100	100	100	106	102	67	57	65	86	106	106	104	1099
(mm)	1/20	97	97	97	105	99	64	53	62	83	105	105	103	1070
Annual	Kc	0.66	-	0.53	0.89	1.00	0.98	0.66	-	0.53	0.89	1.00	0.98	-
Crop	ETC (mm)	58.7	-	46.1	69.1	79.8	75.9	55.4	-	37.8	63.7	73.5	78.7	638.7
	1/2	-	-	-	-	-	-	-	-	-	-	-	-	-
	1/5	-	-	-	-	-	3.9	-	-	-	-	-	-	3.9
	1/10	-	-	-	-	-	8.9	-	-	-	-	-	-	8.9
	1/20	-	-	-	-	-	11.9	2.4	-	-	-	-	-	14.3
Tree Crop	Kc	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	-
	ETC (mm)	80.09	74.89	78.32	69.84	71.83	69.68	75.55	75.15	64.18	64.44	66.19	72.24	862.40
	1/2	-	-	-	-	-	-	6.6	-	-	-	-	-	6.55
	1/5	-	-	-	-	-	-	14.6	5.1	-	-	-	-	19.70
	1/10	-	-	-	-	-	2.7	18.6	10.1	-	-	-	-	31.38
	1/20	-	-	-	-	-	5.7	22.6	13.1	-	-	-	-	41.38

Table H.1.2 Crop Water Requirement (6) Genova

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
	ETP(mm)	89.0	83.2	87.0	80.2	79.8	80.0	83.9	83.5	73.7	71.6	76.0	80.3	968.2
Rainfall	R (mm)	107	117	159	176	170	101	56	80	133	253	184	124	1660
	1/2	86	90	102	103	103	82	50	69	95	106	103	92	1081
Effective	1/5	74	79	94	99	97	71	42	58	86	106	100	83	989
Rainfall	1/10	68	73	90	94	92	65	37	53	80	104	96	76	928
(mm)	1/20	63	68	86	90	89	60	34	49	75	103	92	71	880
Annual	Kc	0.66	-	0.53	0.89	1.00	0.98	0.66	-	0.53	0.89	1.00	0.98	-
Crop	ETC (mm)	58.7	-	46.1	71.4	79.8	78.4	55.4	-	39.1	63.7	76.0	78.7	647.3
	1/2	-	-	-	-	-	-	5.4	-	-	-	-	-	5.4
	1/5	-	-	-	-	-	7.4	13.4	-	-	-	-	-	20.8
	1/10	-	-	-	-	-	13.4	18.4	-	-	-	-	2.7	34.5
	1/20	-	-	-	-	-	18.4	21.4	-	-	-	-	7.7	47.5
Tree Crop	Kc	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	-
	ETC (mm)	80.09	74.89	78.32	72.17	71.83	72.01	75.55	75.15	66.32	64.44	68.39	72.24	871.39
	1/2	-	-	-	-	-	-	25.6	6.1	-	-	-	-	31.70
	1/5	6.1	-	-	-	-	1.0	33.6	17.1	-	-	-	-	57.79
	1/10	12.1	1.9	-	-	-	7.0	38.6	22.1	-	-	-	-	81.68
	1/20	17.1	6.9	-	-	-	12.0	41.6	26.1	-	-	-	1.2	104.92

Table H.1.3 Irrrigation Water Requirement (1)

(unit l/s/ha)

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Circasia														
Annual Crop	PWQ	0.227	0.000	0.182	0.292	0.324	0.298	0.220	0.000	0.177	0.288	0.326	0.313	2.648
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1/5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1/10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1/20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tree Crop	PWQ	0.310	0.276	0.309	0.295	0.292	0.274	0.300	0.304	0.301	0.292	0.293	0.288	3.533
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1/5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1/10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1/20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Salento														
Annual Crop	PWQ	0.295	0.000	0.245	0.375	0.542	0.521	0.295	0.000	0.246	0.408	0.462	0.432	3.821
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.022
	1/5	0.000	0.000	0.000	0.000	0.000	0.067	0.005	0.000	0.000	0.000	0.000	0.000	0.072
	1/10	0.000	0.000	0.000	0.000	0.000	0.095	0.022	0.000	0.000	0.000	0.000	0.000	0.118
	1/20	0.000	0.000	0.000	0.000	0.000	0.118	0.039	0.000	0.000	0.000	0.000	0.000	0.158
Tree Crop	PWQ	0.402	0.397	0.417	0.379	0.488	0.478	0.402	0.407	0.418	0.412	0.415	0.397	5.013
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.000	0.067	0.049	0.000	0.000	0.000	0.000	0.117
	1/5	0.000	0.000	0.000	0.000	0.000	0.025	0.113	0.095	0.000	0.000	0.000	0.000	0.232
	1/10	0.000	0.000	0.000	0.000	0.000	0.053	0.130	0.117	0.000	0.000	0.000	0.000	0.300
	1/20	0.000	0.000	0.000	0.000	0.000	0.076	0.147	0.134	0.000	0.000	0.000	0.000	0.357
Quindio Right Margin														
Annual Crop	PWQ	0.410	0.000	0.332	0.487	0.570	0.549	0.410	0.000	0.306	0.482	0.520	0.558	4.625
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.005
	1/5	0.000	0.000	0.000	0.000	0.000	0.050	0.013	0.000	0.000	0.000	0.000	0.031	0.094
	1/10	0.000	0.000	0.000	0.000	0.000	0.078	0.047	0.000	0.000	0.000	0.000	0.053	0.179
	1/20	0.002	0.000	0.000	0.000	0.003	0.101	0.070	0.000	0.000	0.000	0.000	0.076	0.251
Tree Crop	PWQ	0.559	0.498	0.564	0.492	0.513	0.504	0.559	0.564	0.520	0.488	0.468	0.513	6.243
	MWQ 1/2	0.043	0.000	0.000	0.000	0.000	0.000	0.106	0.059	0.000	0.000	0.000	0.000	0.208
	1/5	0.094	0.000	0.000	0.000	0.000	0.005	0.162	0.116	0.000	0.000	0.000	0.000	0.377
	1/10	0.128	0.015	0.025	0.000	0.000	0.034	0.196	0.150	0.000	0.000	0.000	0.008	0.556
	1/20	0.151	0.044	0.042	0.000	0.000	0.056	0.219	0.172	0.010	0.000	0.000	0.030	0.725

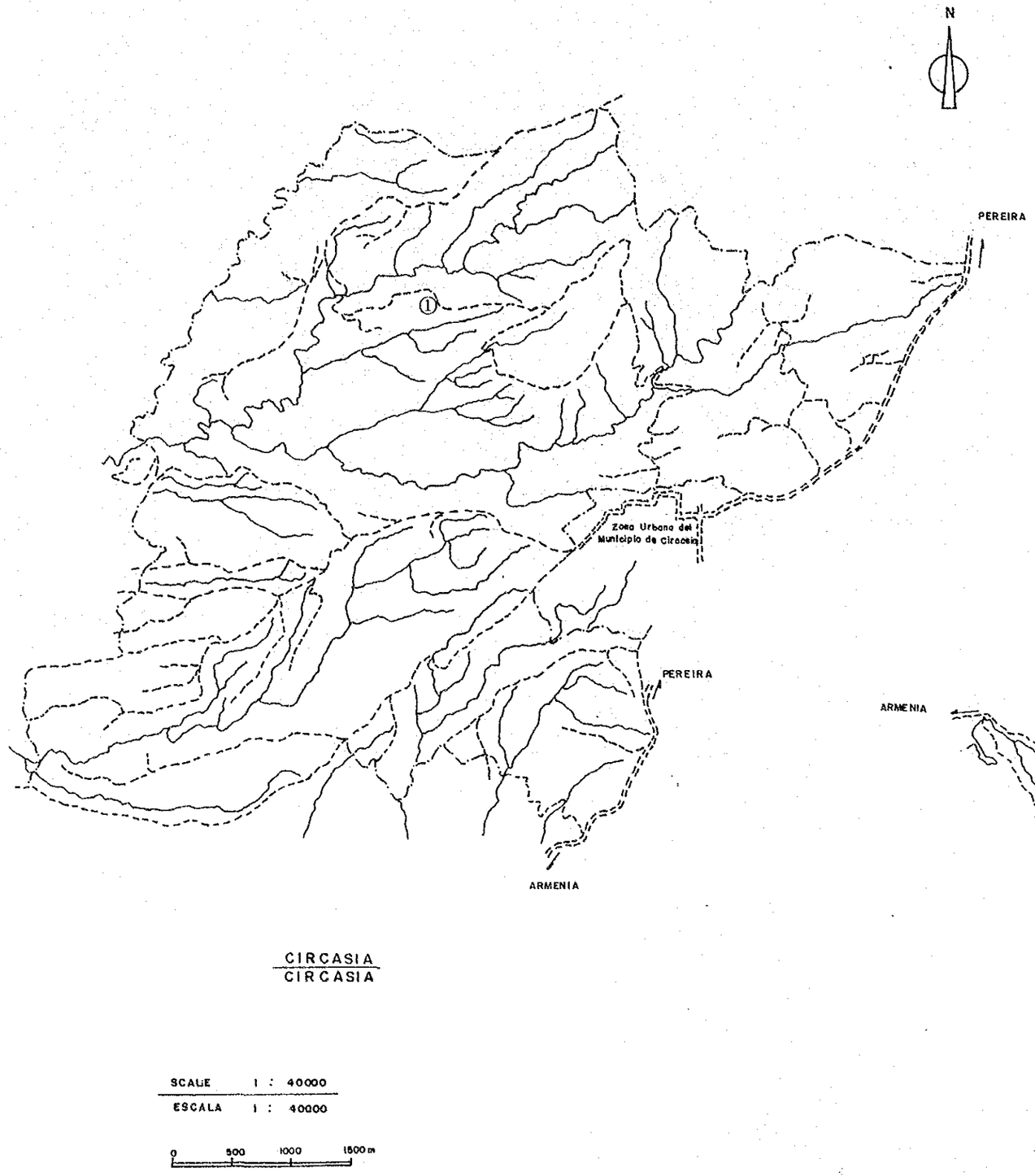
Note : PWQ=Peak Irrgation Water Wequirement MWQ=Mean Irrgation Water Requirement

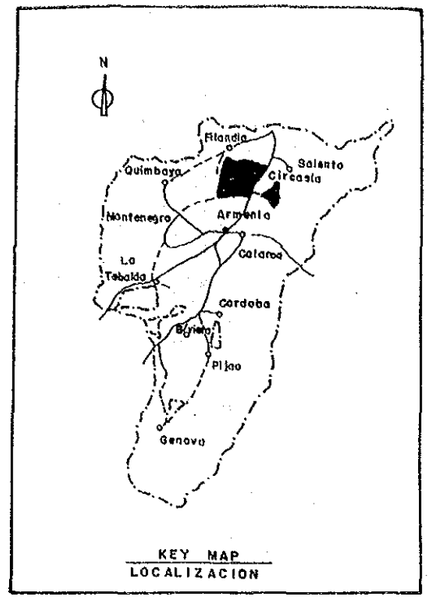
Table H.1.3 Irrrigation Water Requirement (2)

(unit l/s/ha)

Item		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Quindio Left Margin														
Annual Crop	PWQ	0.403	0.000	0.332	0.522	0.563	0.572	0.428	0.000	0.317	0.479	0.543	0.562	4.722
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.113	0.088	0.000	0.000	0.000	0.000	0.000	0.200
	1/5	0.000	0.000	0.000	0.000	0.000	0.164	0.133	0.000	0.000	0.000	0.000	0.000	0.297
	1/10	0.000	0.000	0.000	0.000	0.000	0.186	0.156	0.000	0.000	0.000	0.000	0.018	0.360
	1/20	0.000	0.000	0.000	0.000	0.000	0.209	0.173	0.000	0.000	0.000	0.000	0.035	0.417
Tree Crop	PWQ	0.550	0.517	0.564	0.528	0.507	0.525	0.584	0.583	0.538	0.485	0.488	0.516	6.386
	MWQ 1/2	0.005	0.000	0.000	0.000	0.000	0.066	0.243	0.118	0.000	0.000	0.000	0.000	0.432
	1/5	0.039	0.029	0.000	0.000	0.000	0.117	0.289	0.169	0.000	0.000	0.000	0.000	0.643
	1/10	0.062	0.052	0.000	0.000	0.000	0.140	0.312	0.192	0.010	0.000	0.000	0.000	0.767
	1/20	0.079	0.075	0.000	0.000	0.000	0.162	0.329	0.214	0.022	0.000	0.000	0.000	0.881
Pijao														
Annual Crop	PWQ	0.333	0.000	0.262	0.392	0.453	0.430	0.314	0.000	0.214	0.362	0.417	0.446	3.624
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1/5	0.000	0.000	0.000	0.000	0.000	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.022
	1/10	0.000	0.000	0.000	0.000	0.000	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.050
	1/20	0.000	0.000	0.000	0.000	0.000	0.067	0.014	0.000	0.000	0.000	0.000	0.000	0.081
Tree Crop	PWQ	0.454	0.425	0.444	0.396	0.408	0.395	0.429	0.426	0.364	0.366	0.376	0.410	4.893
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.000	0.037	0.000	0.000	0.000	0.000	0.000	0.037
	1/5	0.000	0.000	0.000	0.000	0.000	0.000	0.083	0.029	0.000	0.000	0.000	0.000	0.112
	1/10	0.000	0.000	0.000	0.000	0.000	0.015	0.105	0.058	0.000	0.000	0.000	0.000	0.178
	1/20	0.000	0.000	0.000	0.000	0.000	0.032	0.128	0.075	0.000	0.000	0.000	0.000	0.235
Genova														
Annual Crop	PWQ	0.333	0.000	0.262	0.405	0.453	0.445	0.314	0.000	0.222	0.362	0.431	0.446	3.672
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.000	0.031	0.000	0.000	0.000	0.000	0.000	0.031
	1/5	0.000	0.000	0.000	0.000	0.000	0.042	0.076	0.000	0.000	0.000	0.000	0.000	0.118
	1/10	0.000	0.000	0.000	0.000	0.000	0.076	0.104	0.000	0.000	0.000	0.000	0.015	0.196
	1/20	0.000	0.000	0.000	0.000	0.000	0.104	0.121	0.000	0.000	0.000	0.000	0.043	0.269
Tree Crop	PWQ	0.454	0.425	0.444	0.409	0.408	0.409	0.429	0.426	0.376	0.366	0.388	0.410	4.944
	MWQ 1/2	0.000	0.000	0.000	0.000	0.000	0.000	0.145	0.035	0.000	0.000	0.000	0.000	0.180
	1/5	0.035	0.000	0.000	0.000	0.000	0.006	0.190	0.097	0.000	0.000	0.000	0.000	0.328
	1/10	0.069	0.011	0.000	0.000	0.000	0.040	0.219	0.126	0.000	0.000	0.000	0.000	0.463
	1/20	0.097	0.039	0.000	0.000	0.000	0.068	0.236	0.148	0.000	0.000	0.000	0.007	0.595

Note : PWQ=Peak Irrgation Water Wequirement MWQ=Mean Irrgation Water Requirement





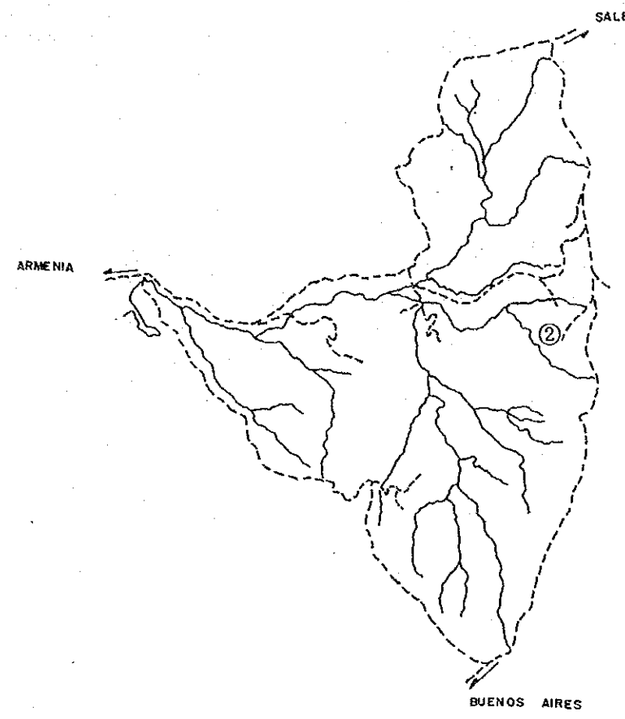
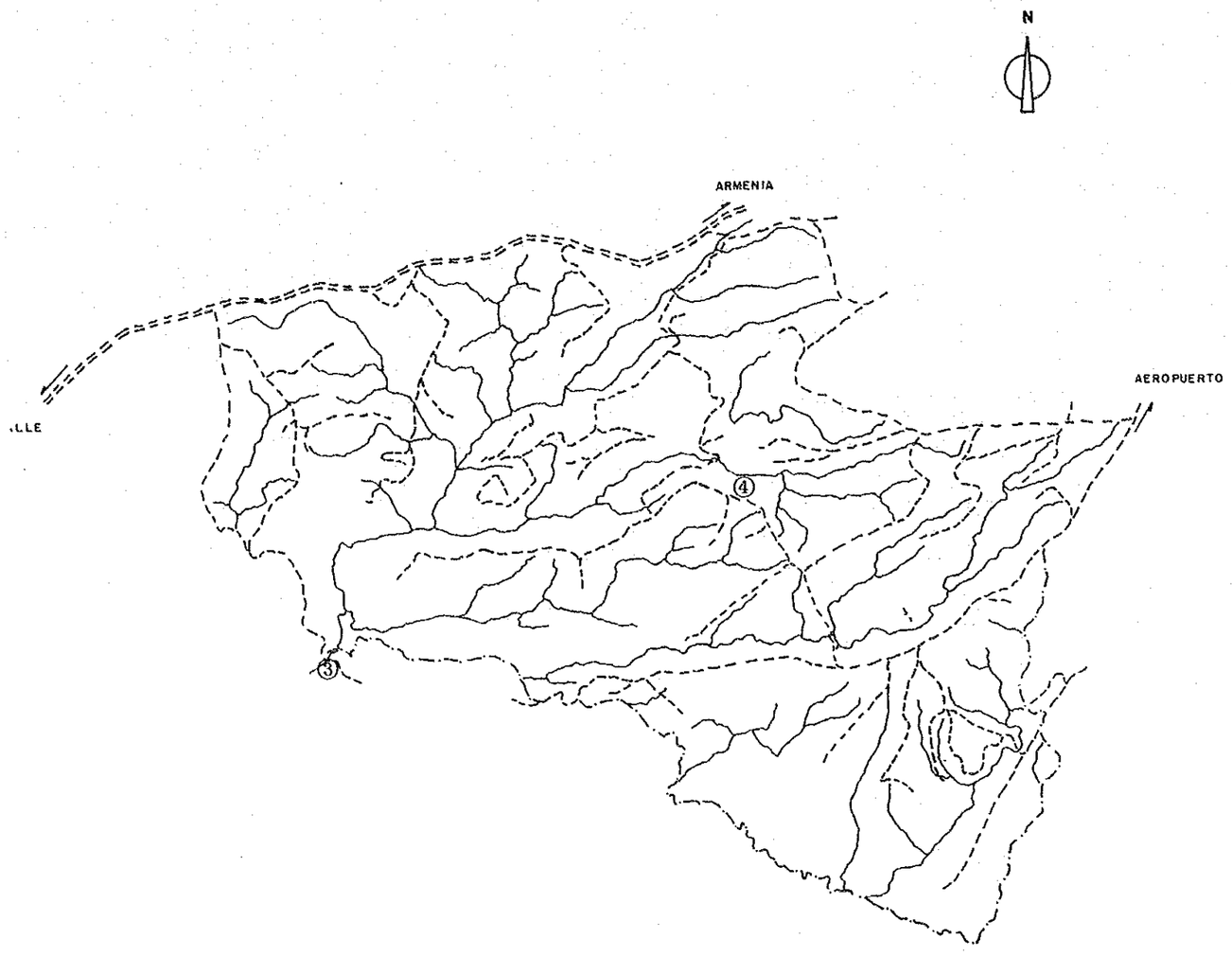


Fig.H.1.1 Points of Intake Rate Test (1)



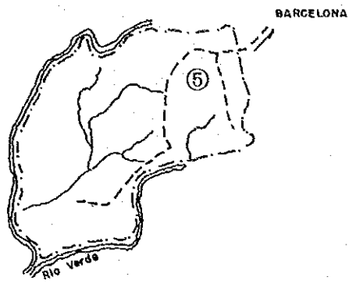
QUINDIO RIVER RIGHT MARGIN

MARGEN DERECHA DEL RIO QUINDIO

SCALE 1 : 40000

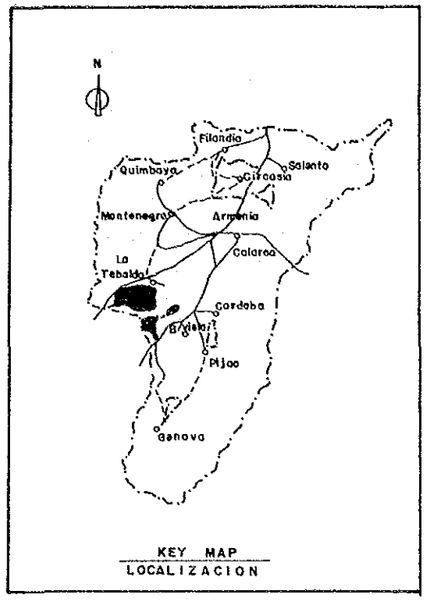
ESCALA 1 : 40000

0 500 1000 1500 m



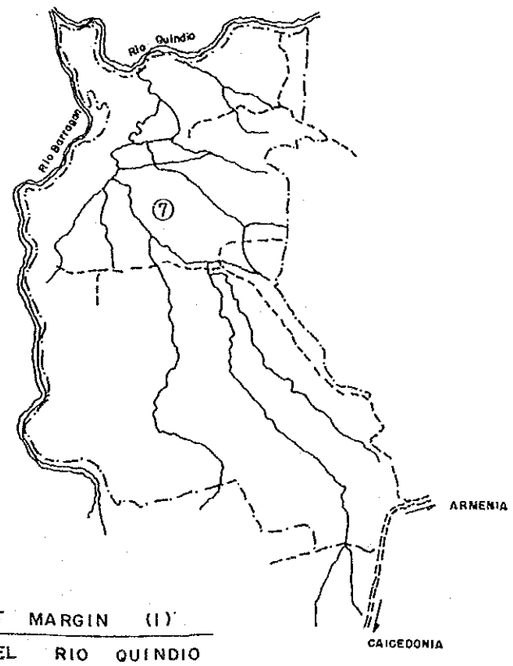
QUINDIO RIVER LEFT MARGIN (2)

MARGEN IZQUIERDA DEL RIO QUINDIO (2)



KEY MAP

LOCALIZACION



QUINDIO RIVER LEFT MARGIN (1)

MARGEN IZQUIERDA DEL RIO QUINDIO

Fig.H.1.1 Points of Intake Rate Test (2)

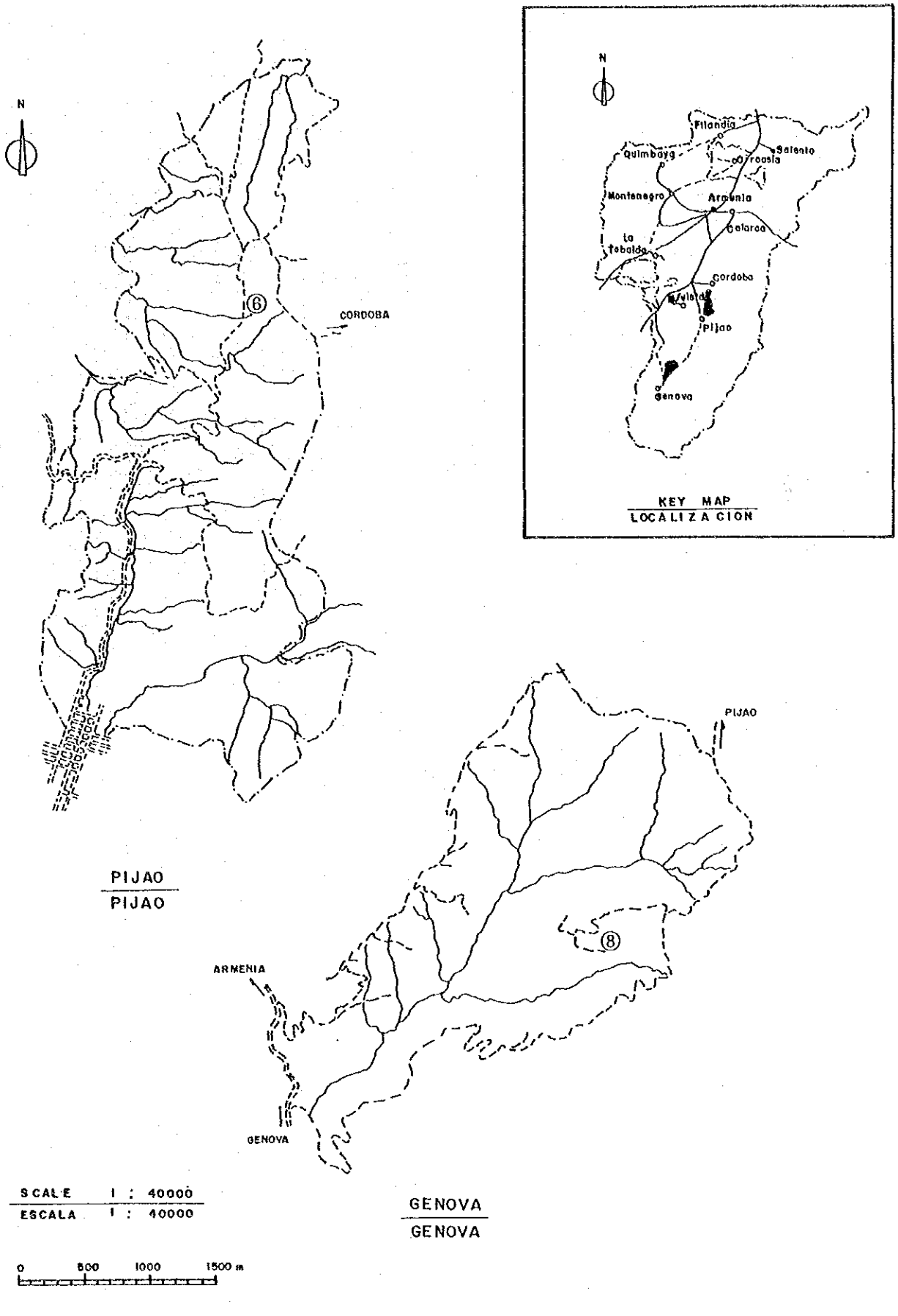


Fig.H.1.1 Points of Intake Rate Test (3)

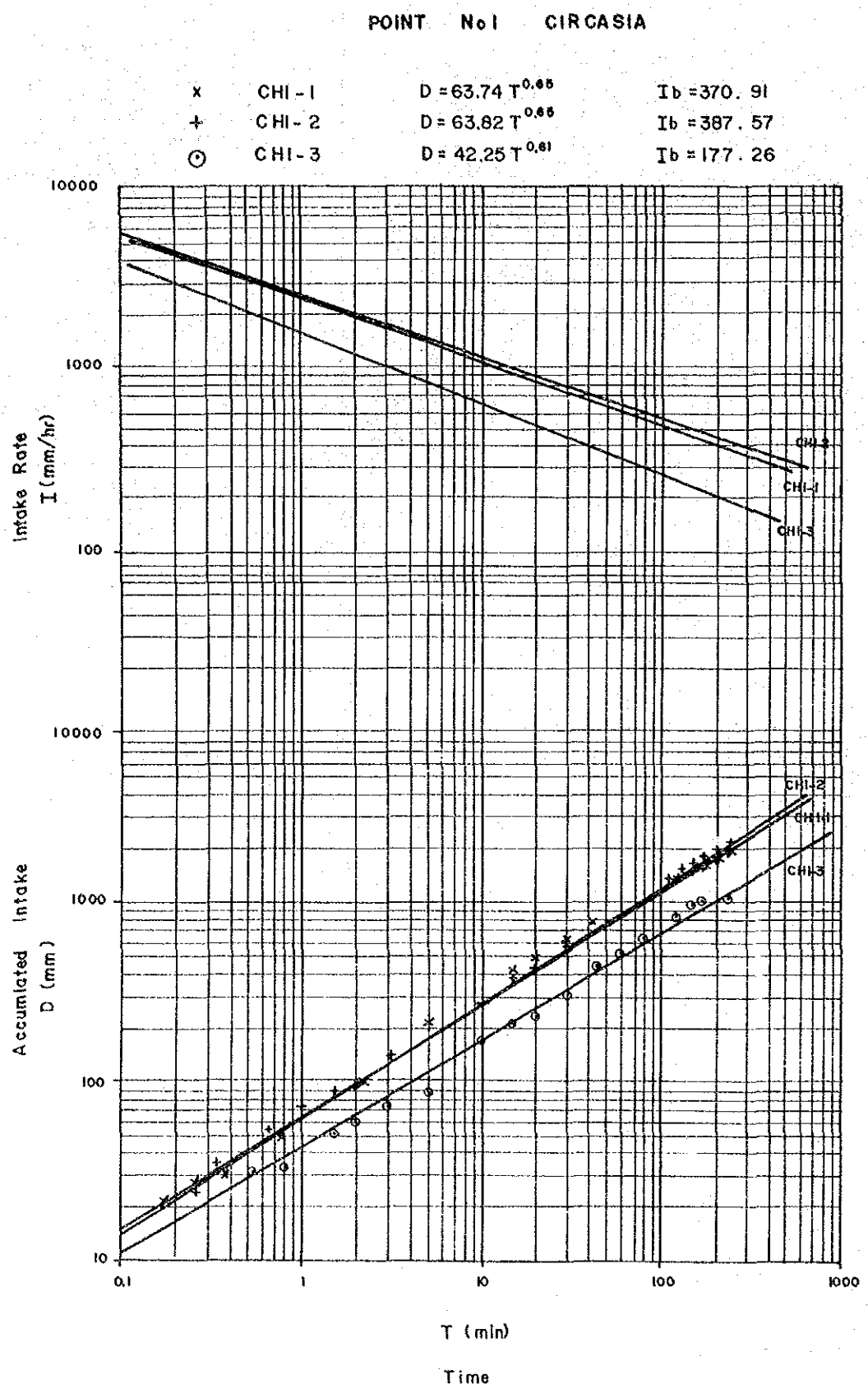


Fig.H.1.2 Intake Rate (1) Point No.1

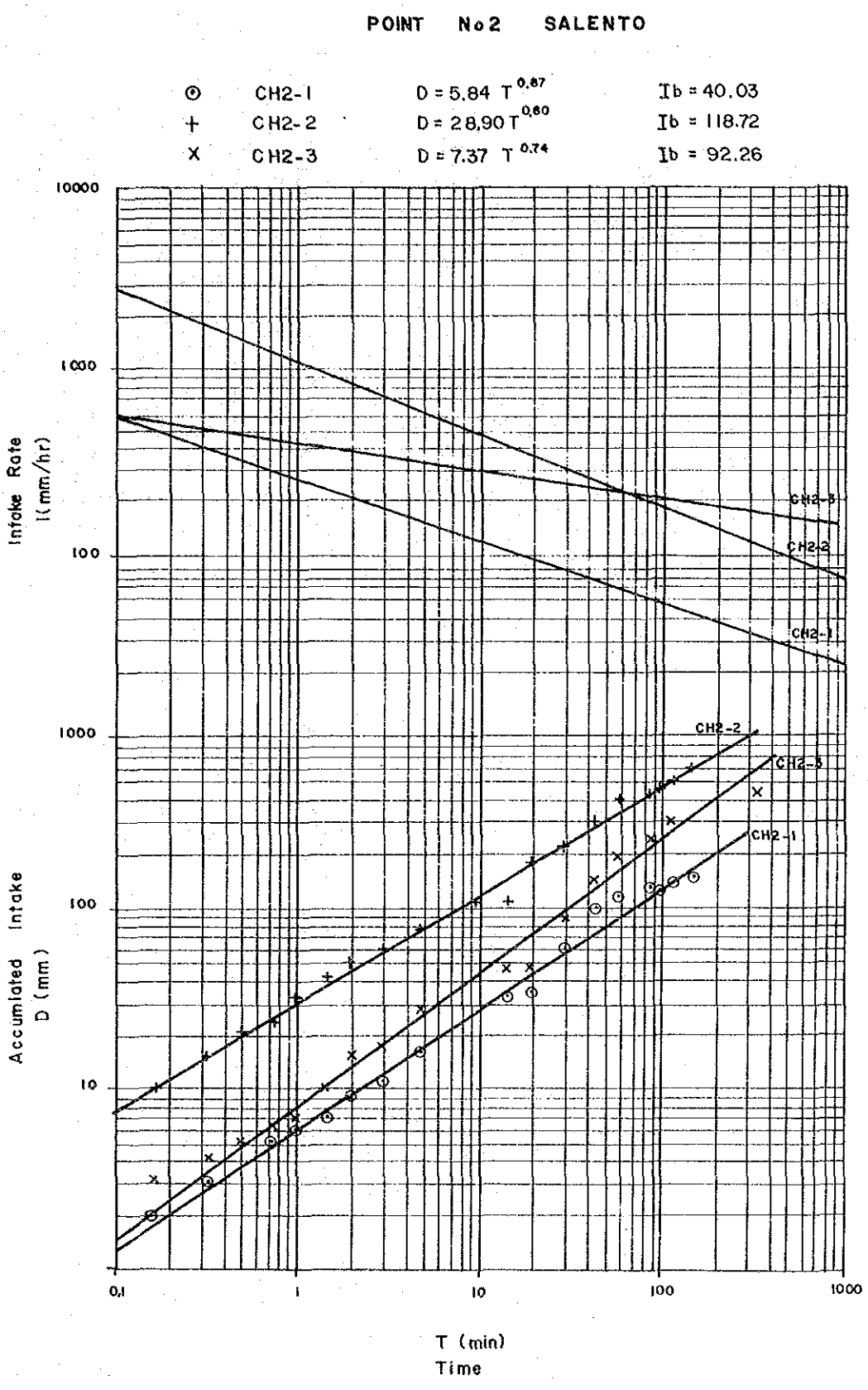


Fig.H.1.2 Intake Rate (2) Point No.2

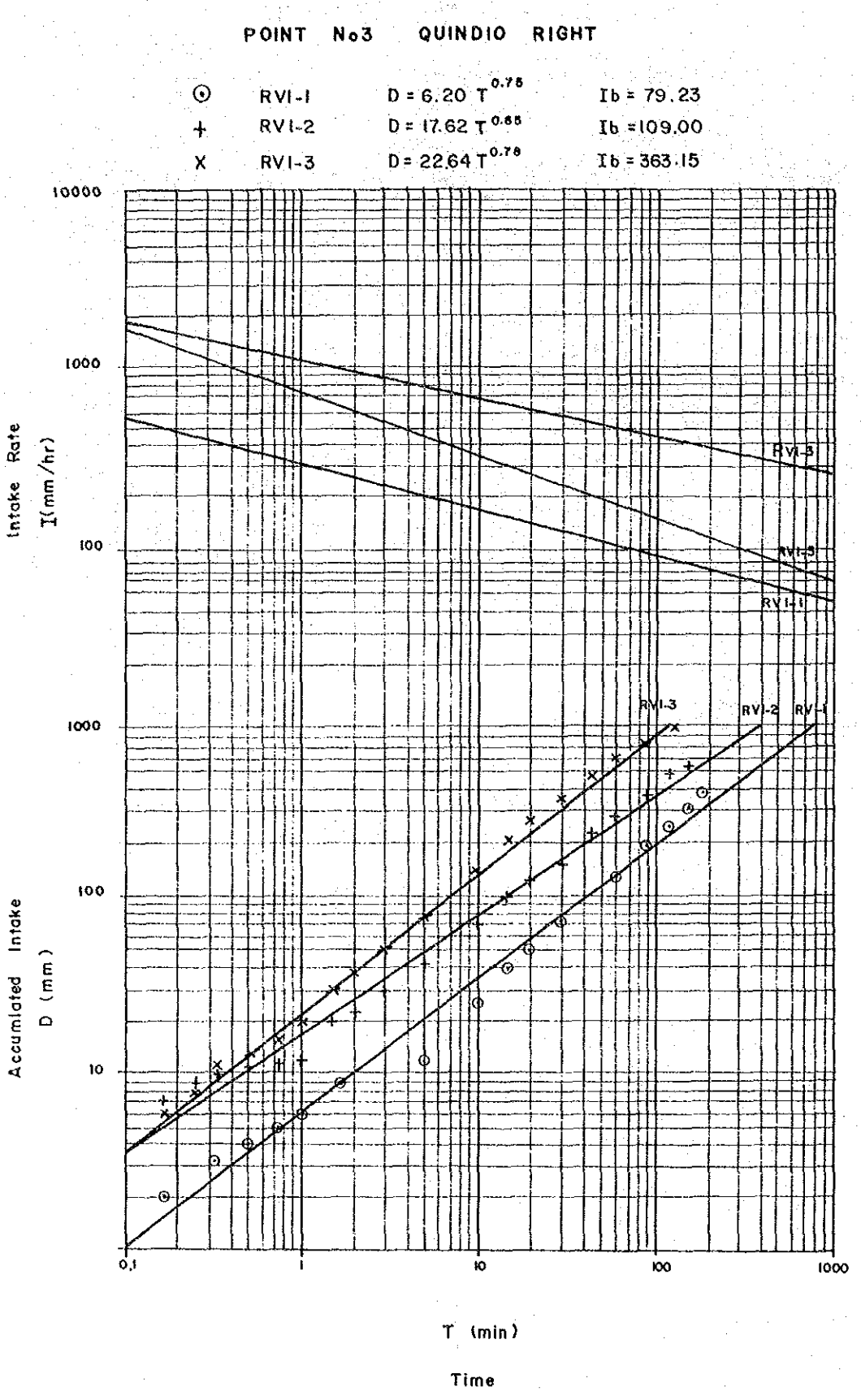


Fig.II.1.2 Intake Rate (3) Point No.3

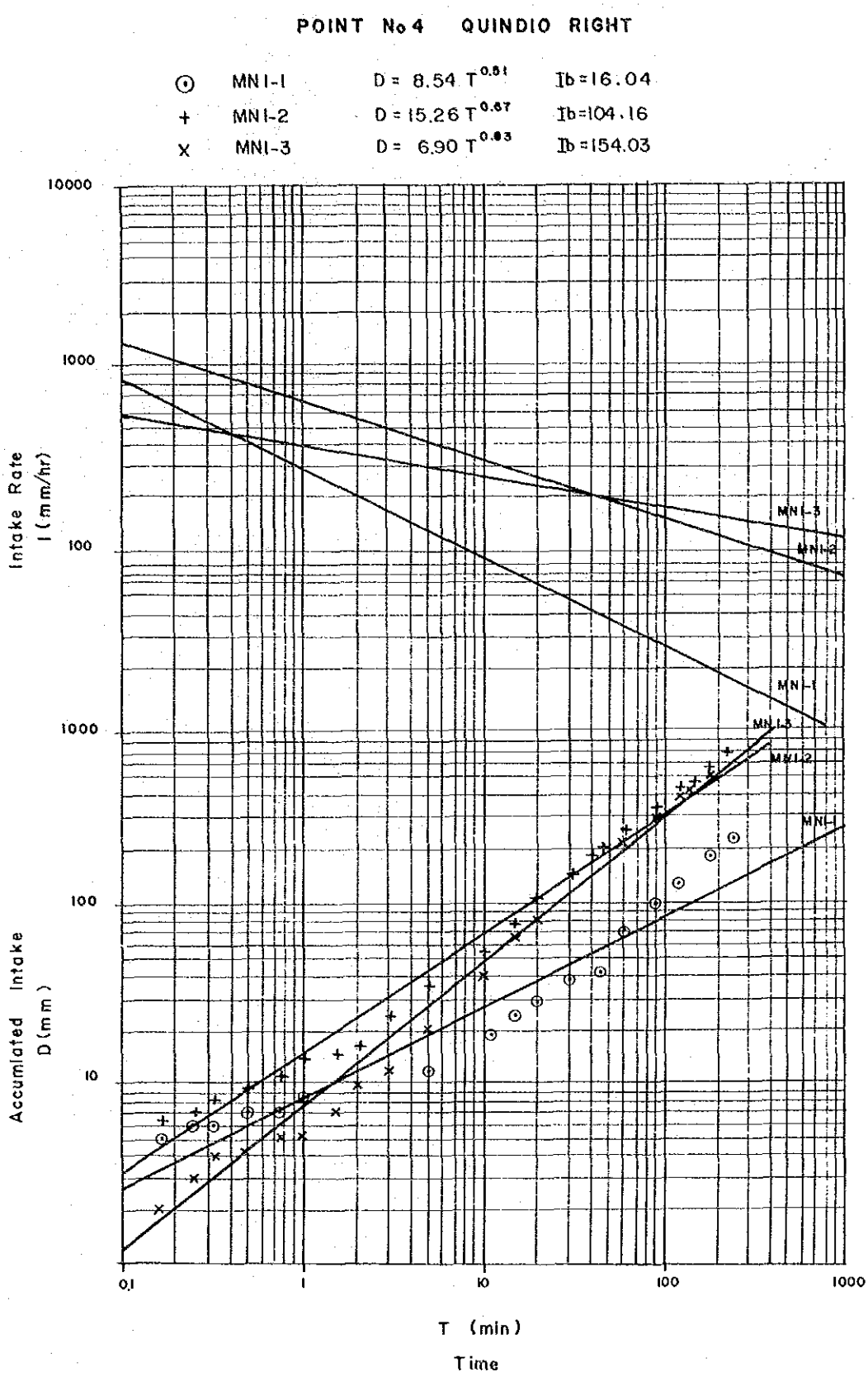


Fig.H.1.2 Intake Rate (4) Point No.4

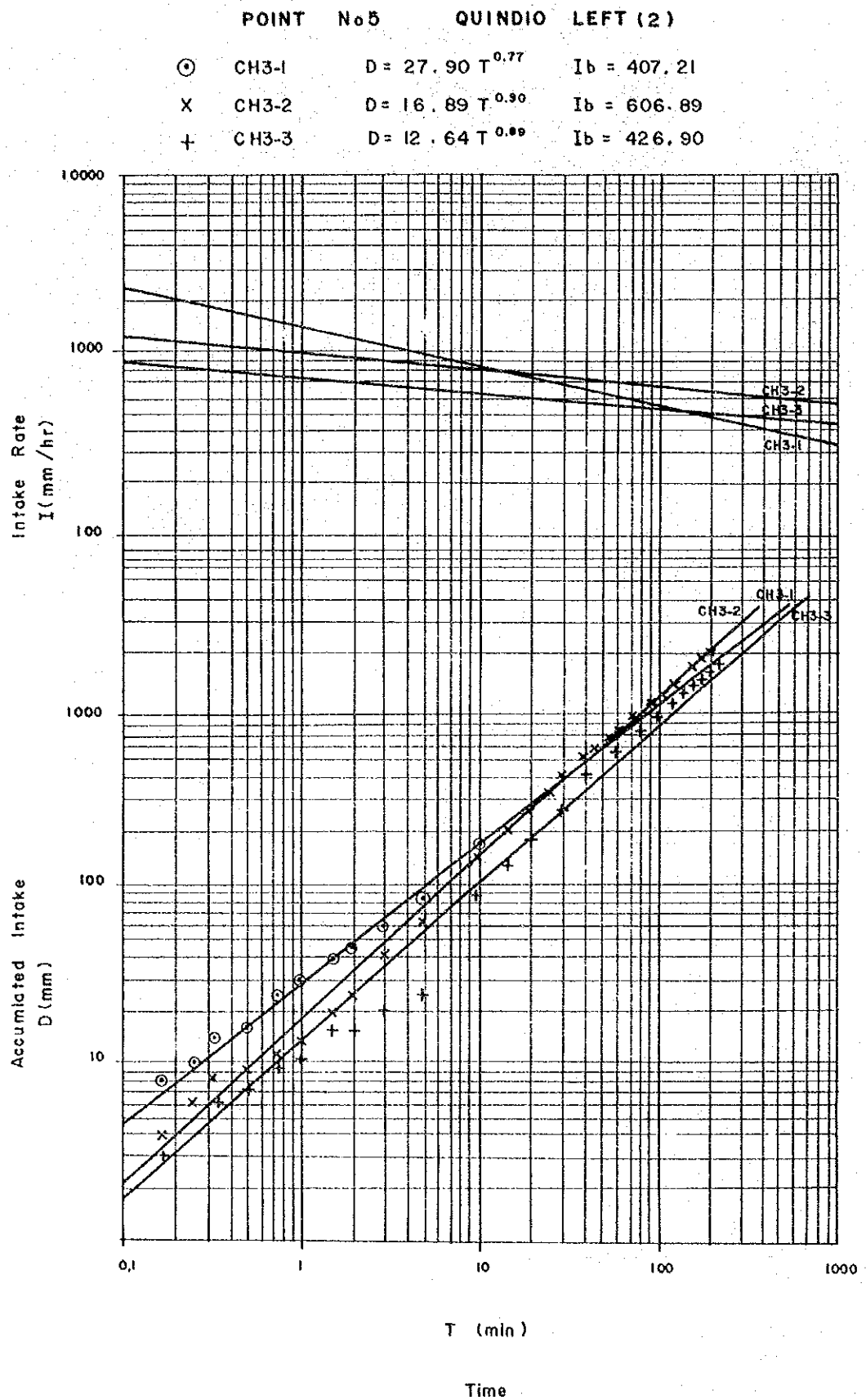


Fig.II.1.2 Intake Rate (5) Point No.5

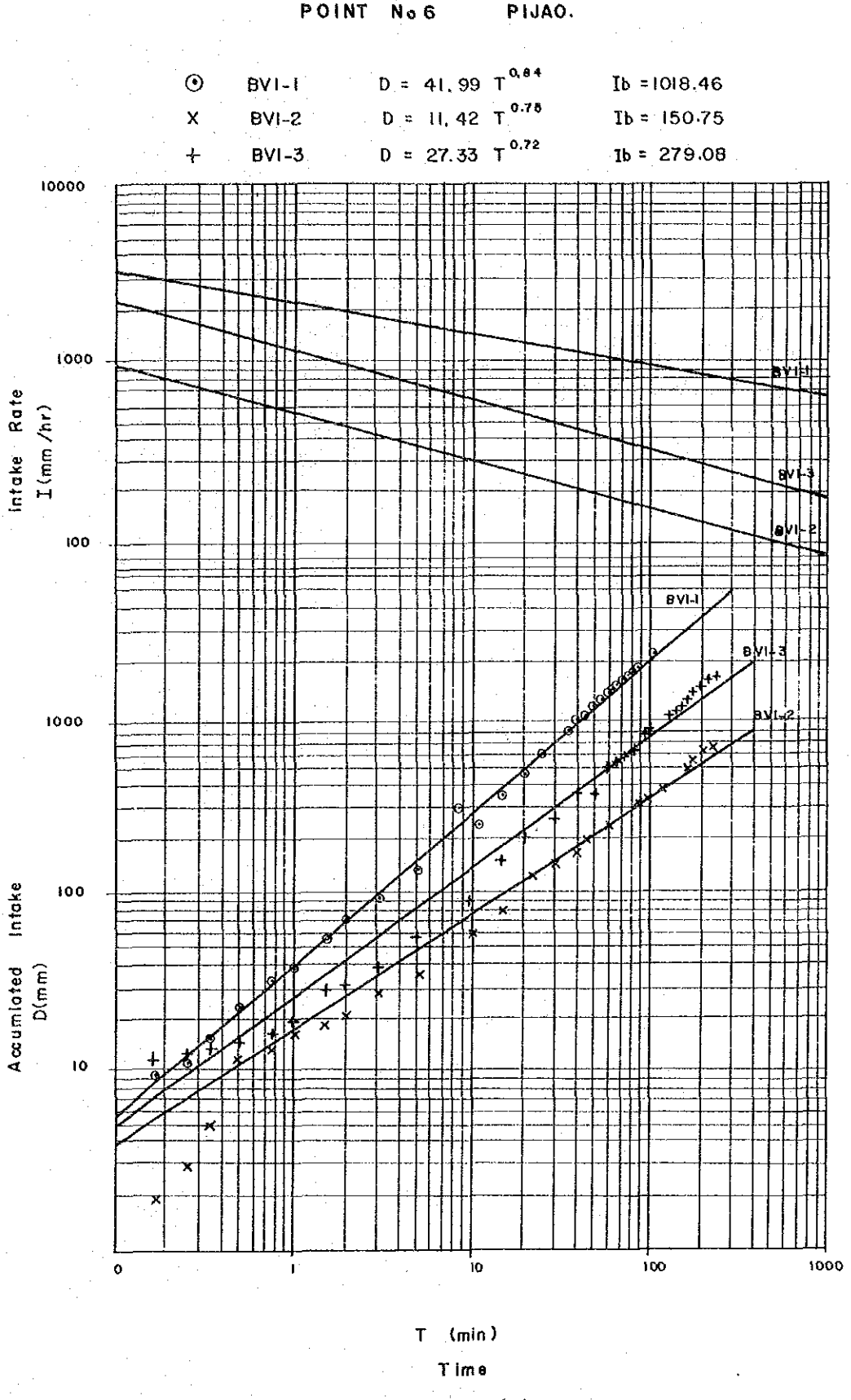


Fig.H.1.2 Intake Rate (6) Point No.6

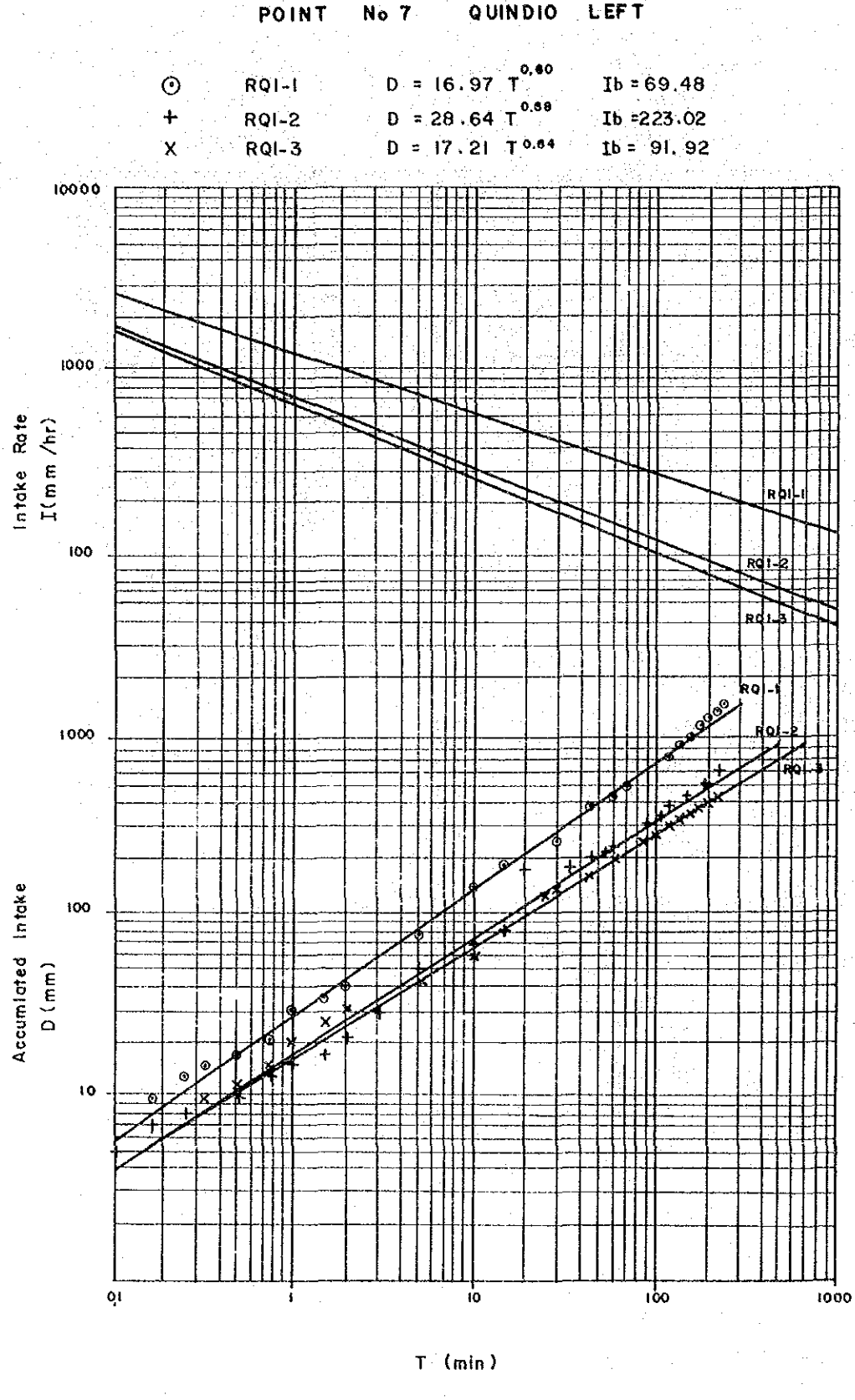


Fig.H.1.2 Intake Rate (7) Point No.7

POINT No 8 GENOVA

⊙	GHI-1	$D=21.54T^{0.76}$	Ib=300.94
×	GHI-2	$D=27.45T^{0.77}$	Ib=408.87
+	GHI-3	$D=19.37T^{0.68}$	Ib= 55.36

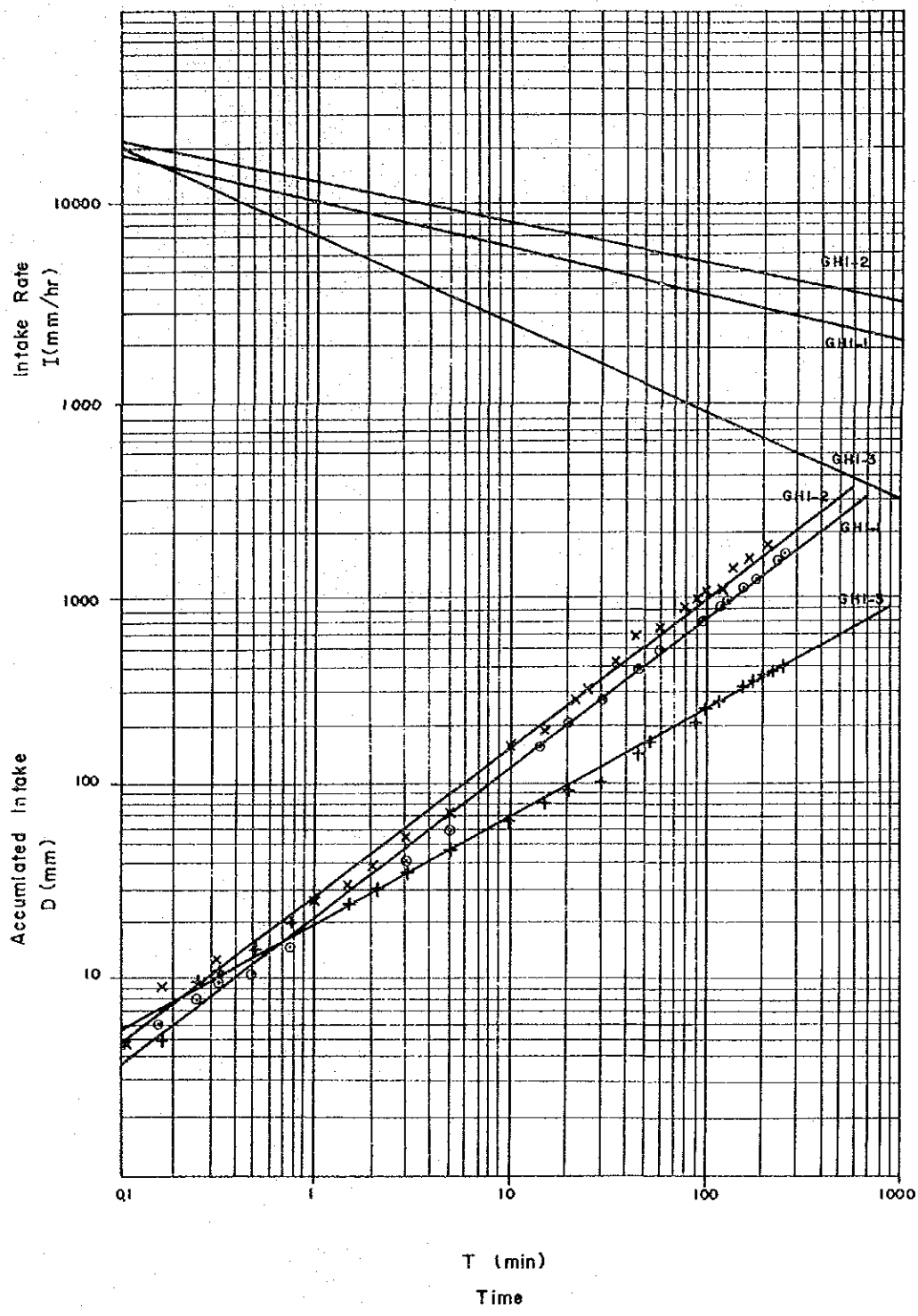


Fig.H.1.2 Intake Rate (8) Point No.8

Table H.1.4 Constants of Intake Rate

$I=k*T^n$

Point No.		k	n	Ib	Remark
No. 1	CH1-1	63.74	0.65	370.91	Circasia
	CH1-2	63.82	0.65	387.57	
	CH1-3	42.25	0.61	177.26	
	Mean	56.60	0.64	311.91	
No. 2	CH2-1	5.84	0.67	40.03	Salento
	CH2-2	28.90	0.60	118.72	
	CH2-3	7.37	0.74	92.26	
	Mean	14.04	0.67	83.67	
No. 3	RV1-1	6.20	0.75	79.23	Quindio
	RV1-2	17.62	0.65	109.00	Right
	RV1-3	22.64	0.78	363.15	
	Mean	15.49	0.73	183.79	
No. 4	MN1-1	8.54	0.51	16.04	Quindio
	MN1-2	15.26	0.67	104.16	Right
	MN1-3	6.90	0.83	154.03	
	Mean	10.23	0.67	91.41	
No. 5	CH3-1	27.90	0.77	407.21	Quindio
	CH3-2	16.89	0.90	606.89	Left (2)
	CH3-3	12.64	0.89	426.90	
	Mean	19.14	0.85	480.33	
No. 6	BV1-1	41.99	0.84	1018.46	Pijao
	BV1-2	11.42	0.75	150.75	
	BV1-3	27.33	0.72	279.08	
	Mean	26.91	0.77	482.76	
No. 7	RQ1-1	16.97	0.60	69.48	Quindio
	RQ1-2	28.64	0.68	223.02	Left (1)
	RQ1-3	17.21	0.64	91.92	
	Mean	20.94	0.64	128.14	
No. 8	GH1-1	21.54	0.76	300.94	Genova
	GH1-2	27.45	0.77	408.87	
	GH1-3	19.37	0.56	55.36	
	Mean	22.79	0.70	255.06	

Table II.1.5 Field Capcity and Available Moisture

Sample	FCW	SDW	FCWP	WP	AM	DP	RAM
CH1-1	128.80	86.90	41.90	36.00	5.90	36.50	5.40
CH1-2	157.50	117.40	40.10	30.70	9.40	31.90	8.20
CH1-3	163.10	123.90	39.20	26.50	12.70	34.20	5.00
CH2-1	159.80	118.00	41.80	33.00	8.80	37.50	4.30
CH2-2	170.90	130.20	40.70	35.81	4.89	38.50	2.20
CH2-3	175.20	136.90	38.30	15.70	22.60	16.40	21.90
RV1-1	151.30	103.20	48.10	43.10	5.00	43.69	4.41
RV1-2	148.80	98.00	50.80	42.10	8.70	43.90	6.90
RV1-3	179.10	106.20	72.90	64.70	8.20	66.40	6.50
MN1-1	173.90	137.60	36.30	29.90	6.40	32.80	3.50
MN1-2	174.30	130.70	43.60	36.20	7.40	41.20	2.40
MN1-3	198.60	130.90	67.70	48.20	19.50	62.50	5.20
CH3-1	167.50	123.90	43.60	40.21	3.39	41.20	2.40
CH3-2	176.80	133.50	43.30	41.80	1.50	42.80	0.50
CH3-3	179.20	135.30	43.90	31.20	12.70	36.30	7.60
BV1-1	171.50	124.50	47.00	41.50	5.50	41.93	5.07
BV1-2	183.50	142.50	41.00	37.81	3.19	38.12	2.88
BV1-3	177.60	138.70	38.90	33.30	5.60	33.83	5.07
RQ1-1	197.40	162.00	35.40	34.59	0.81	34.62	0.78
RQ1-2	192.20	154.00	38.20	33.29	4.91	33.76	4.44
RQ1-3	189.00	152.20	36.80	35.30	1.50	35.73	1.07
GH1-1	171.40	132.60	38.80	38.49	0.31	38.52	0.28
GH1-2	186.10	147.10	39.00	34.91	4.09	35.05	3.95
GH1-3	187.30	148.10	39.20	27.50	11.70	27.74	11.46

Note FCW : Weight of wet soil of field capacity (g)
SDW : Weight of dry soil (g)
FCWP : Water content of field capacity (%)
WP : Water contente of wilting point (%)
AM : Available moisture (%)
DP : Depletion of water content for optimum growth (%)
RAM : Readily Available moisture (%)

Table H.1.6 Required Catchement Area for Irrgation (km2/ha)

Return Period		1/2	1/5	1/10	1/20
Drought Discharge (m3/s/km2)		0.00898	0.00595	0.00482	0.00426
Avairable Discharge(m3/s/km2)		0.00718	0.00476	0.00386	0.00341
Area	W.Requirement (l/s/ha)				
Circasia	0.326	4.538	6.849	8.454	9.566
Salento	0.542	7.545	11.387	14.056	15.904
Q.Right	0.570	7.934	11.975	14.782	16.725
Q.Left	0.584	8.129	12.269	15.145	17.136
Pijao	0.453	6.306	9.517	11.748	13.292
Genova	0.453	6.306	9.517	11.748	13.292

H.1.3 Selection of Irrigation Areas

The farmlands having streams to become water sources in the neighboring area and the flow rate of the streams is in plenty (the catchment area is large) were selected as irrigation areas out of farmlands where annual crops (mainly vegetables) are to be planted.

The selected farmlands are as follows.

(1) Circasia Area: The following three areas were selected.

C-A : 10 ha
C-B : 19 ha
C-C : 9 ha

(2) Salento Area: The annual crop farms are small and the stream flow rates are anot rich. In addition, have a great deal of rain in this Area and accordingly, the necessity of irrigation is minor. Therefore, no irrigation is planned in this area.

(3) Quindio River Right Margin Area: The following seven areas were selected.

Q-A : 10 ha
Q-B : 9 ha
Q-C : 14 ha
Q-D : 7 ha
Q-E : 18 ha
Q-F : 6 ha
Q-G : 10 ha

(4) Quindio River Left Margin (1) (2) Areas:
Although there are farmlands which can be introduced irrigation, the improvement of drainage is rather the previous decision in areas where water sources are available. On the other hand, the farmlands requiring irrigation have no water sources. Therefore, no irrigation is planned in this areas.

(5) Pijao Area: The farmlands requiring irrigation are of a small area. Therefore, no irrigation is made because there are no merits of introduction of irrigation.

(6) Genova Area: There are no farmlands which introduce irrigation.

H.1.4 Water Requirement

The water requirement is calculated from already obtained ETc.

$$Wr = \frac{ETc \times 10}{Ep \times 86,400} = 0.00051 \ m^3/Sec/ha$$

where; Wr: Water Requirement(m^3/Sec/ha)
ETc: Consumptive use of water (mm/day) = 3 mm/day
Ep: Irrigation efficiency (decimal number) = 0.68

H.1.5 Amount of Intake Water

The amount of available intake water in each area was determined as follows assuming that 80% of the estimated discharge of each stream is used.

Table H.1.5.1 Available Water in each Area

	Catchment area (ha)	Discharge of Stream (l/s)	Available water (l/s)
Circasia Area			
C-A	89.0	9.94	7.95
C-B	227.0	25.49	20.39
C-C	107.0	12.01	9.61
Quindio River Right Margin Area			
Q-A	110.0	12.35	9.88
Q-B	73.0	8.18	6.54
Q-C	433.0	48.63	38.90
Q-D	92.0	10.33	8.26
Q-E	282.0	31.67	25.34
Q-F	126.0	14.11	11.29
Q-G	3,721.0	417.87	334.30

H.1.6 Pumping Facilities

Since the water source is a stream located at a place that is lower than the irrigation farmland in each area, pumping facilities are required for irrigation. The powerless pump requiring less O/M cost are selected.

(1) Pumping capacity

The pumping capacity varies by the supply head to the pump and the delivery head from the pump. A head of 5 m will be secured in this plan with a weir provided in the upstream of the intake point. The pumping capacity in each area is as shown below.

Table H.1.6.1 Volume of Water Delivered

	Supply head(m)	Supplied water(l/min)	Delivery head(m)	Volume of water delivered(l/min)
Circasia Area				
C-A	5.0	477.0	35.0	42.93
C-B	5.0	1,523.0	20.0	228.45
C-C	5.0	576.6	40.0	46.13
Quindio River Right Margin Area				
Q-A	5.0	592.8	27.5	66.69
Q-B	5.0	391.2	15.0	78.24
Q-C	5.0	2,334.0	33.0	219.40
Q-D	5.0	495.6	27.5	55.76
Q-E	5.0	1,520.4	19.0	235.66
Q-F	5.0	677.4	36.5	58.93
Q-G	5.0	3,000.0	58.0	180.00

Table H.1.6.2 Ratio between Volume of Water Delivered and Volume of Water Supplied (Unit : %)

SUPPLY HEAD (M)	DELIVERY HEAD (M)										
	4	6	8	10	15	20	30	40	50	75	100
2	30	20	15	12	8	6	—	—	—	—	—
3	—	30	23	18	12	9	6	—	—	—	—
4	—	—	30	24	16	12	8	6	—	—	—
5	—	—	—	30	20	15	10	8	6	—	—
6	—	—	—	—	24	18	12	9	7	—	—
7	—	—	—	—	28	21	14	11	8	—	—
8	—	—	—	—	—	24	16	12	10	6	—
9	—	—	—	—	—	27	18	14	11	7	—
10	—	—	—	—	—	30	20	15	12	8	6
15	—	—	—	—	—	—	30	23	18	12	9
20	—	—	—	—	—	—	—	30	24	16	12

Notes
1. Standard applicable range for 12-inch size is supply head max. 5m and delivery head max. 50m.
2. Standard applicable ranges for 4-inch, 6-inch and 8-inch sizes are supply head max. 10m and delivery head max. 75m.

(2) Pump size

Table H.1.6.3 Pump size

	Volume of water delivered(l/min)	Pump Size (mm)	Supplied Water(l/m)
Circasia Area			
C-A	42.93	150	477.0
C-B	228.45	200	1,523.0
C-C	46.13	150	576.6
Quindio River			
Right Margin Area			
Q-A	66.69	150	592.8
Q-B	78.24	150	391.2
Q-C	219.40	300	2,334.0
Q-D	55.76	150	495.6
Q-E	235.66	200	1,520.4
Q-F	58.93	150	677.4
Q-G	180.00	300	3,000.0

Table H.1.6.4 Pump Size Selection Table

TYPE	SIZE	VOLUME OF WATER SUPPLIED
CT-L-4	4-inch	175—350 (ℓ/min.)
CT-L-6	6-inch	350—700 (ℓ/min.)
CT-L-8	8-inch	800—1,600 (ℓ/min.)
CT-L-12	12-inch	1,750—3,500 (ℓ/min.)

II.1.7 Farm Pond

(1) Necessity of farm ponds

The following figures are obtained comparing the requirement water for irrigation and delivered water from pump and these figures indicate that farm ponds are required.

Table II.1.7.1 Necessity of farm ponds (abbreviated as "fp")

	Delivered water(l/s)	Required water(l/s)	Difference (l/s)
Circasia Area			
C-A	0.72	13.60	- 12.88
C-B	3.81	25.84	- 22.03
C-C	0.77	12.24	- 11.47
Quindio River Right Margin Area			
Q-A	1.11	13.60	- 12.49
Q-B	1.30	12.24	- 10.94
Q-C	3.66	19.04	- 15.38
Q-D	0.93	9.52	- 8.59
Q-E	3.93	24.48	- 20.55
Q-F	0.98	8.16	- 7.18
Q-G	3.00	13.60	- 10.60

(2) Farm pond capacity

The capacity of each farm pond is calculated as follows.

$$Vf = (Hr \times \frac{3600}{1000}) \times (Qo - Qi)$$

where; hr: Actual irrigation time = 9 hours
Qo: Outflow rate from farm pond (l/s)
Qi: Inflow rate to farm pond (l/s)
Vf: Farm pond capacity (m^3)

Table H.1.7.2 Farm Pond Capacity and Dimension

	Required capacity(m^3)	Effective depth(m)	Dimension (m)
Circasia Area			
C-A	417.33	2.0	12.0x17.5x2.5
C-B	713.77	2.0	16.0x23.0x2.5
C-C	371.63	2.0	11.0x17.0x2.5
Quindio River Right Margin Area			
Q-A	404.68	2.0	12.0x17.0x2.5
Q-B	354.46	2.0	10.0x18.0x2.5
Q-C	498.31	2.0	13.0x19.5x2.5
Q-D	278.32	2.0	10.0x14.0x2.5
Q-E	665.82	2.0	15.0x22.5x2.5
Q-F	232.63	2.0	9.0x13.0x2.5
Q-G	343.00	2.0	10.0x18.0x2.5

H.1.8 Other Irrigation Facilities

(1) Supplied Pipeline

Steel pipes will be used as supplied pipeline because of application of high pressure.

(2) Delivery Pipeline

Hard polyvinyl chloride pipes will be used for delivery pipeline from the pump station to the farm pond.

(3) Pipeline in farmlands

Underground pipeline will be made to the farmlands. The layout of pipelines will be of 200 m interval as a rule because the sprinkler set length is 100 m.

(4) Specification of irrigation

Irrigation will be made using sprinklers, and the specification of irrigation are as shown below.

Irrigated crops	: Vegetables (annual crops)
Irrigation Period	: June, July, August
Irrigation Method	: Medium pressure sprinkler (pressure 2.5kg/cm^)
Net water requirement	: 3 mm/day
Gross water requirement	: 4 mm/day
Interval of irrigaton	: 6 days
Water quality per irrigation	: 24 mm
Sprinkler arrangement	: 18 x 12 m
Discharge of one sprinkler	: 28.5 l/min
Spray diameter	: 27.5 m
Spray intensity	: 7.92 mm/hr
Irrigation hour at a time	: 3 hours

Number of times of sprinkling per day: 3 times
Actual sprinkling time per day : 9 hours
Number of sprinklers per set : 8 in a standard set

ANNEX I : RURAL INFRASTRUCTURE

I.1 Road System and Transportation System

I.1.1 Road System

The road system of Quindio is maintained by the Ministry of Public Works and Transportation (hereinafter refer to as the "MOPT") and has been improved by main office of the MOPT in the Department, by the Secretariat of Public Works of the Department and County Road Division (Camino Vecinales) of the MOPT. The national road is under the jurisdiction of the MOPT and the rural road connecting to the national road is under the Secretariat of Public Works of the Department financed by the Coffee Committee. The MOPT is implementing the improvement of the road connecting Barragan to Genova and this work will be finish in this year (1990). The rural road connecting with the national road of Quindio has been improved according to the 5 years road improvement plan of the Secretariat of Public Works of the Quindio Department (1988-1992). Concerning the study area, the roads from El Balso to Pijao and from Arrayanal to Salento have already been paved. All the construction is financed by the Coffee Committee and, after 1992, the rural road net work plan will be studied in the coffee cultivation area concerned.

I.1.2 Transportation System

There are eighteen (18) taxi companies and eight (8) bus companies in the Quindio, offering transportation between downtown of Armenia and other towns, as a means for the main traffic.

Existing transportations of the study area are as follows:

1) The Circasia Area (1)

From Circasia, there is bus service to Armenia, Montenegro and Quinbaya for every hour (6 A.M. to 8 P.M.). The main transportation service is taxi service by jeep (campero) from Circasia to the inside the study area.

2) The Circasia Area (2)

From Armenia to Salento, there are bus service every two hours, through the rural road in the Canaan area.

3) The Quindio River Right Margin Area

The main transportation service is a taxi service by jeep (campero) from Tebaida to the inside of the study area; there is also taxi and bus service along the national road.

4) The Quindio River Left Margin Area (1) and (2)

There is bus and taxi service along the national road from Armenia to Calcedonia, but there is no public transportation service in the study areas.

5) Pijao Area

The main transportation service is done by bus and taxi service by jeep through the rural road connecting Cordoba to Pijao. There is bus service every two hours, and taxi service approximately every hour.

6) Genova Area

The main transportation service is by bus and taxi through the national road from Barragan to Genova and rural road from Pijao to Genova.

I.2 Water Supply, Sewerge and Electricity

I.2.1 Water Supply and Sewerage

In the study areas, there is no large scale water supply system, however, most of the farmers have a water supply service by the Coffee Committee or have a water supply system there own. Therefore, quite a few farmer has no water supply system.

In the study areas and with the exception of some farms where the sewage is simply treated by infiltration method, the sewage is directly discharged into the rivers.

I.2.2 Electricity

The entire electric power supply and demand of Colombia are controlled by the Adjustment of Electric Corporation (ISA), and electric power is supplied to Quindio by ISA. In the study areas, all farmers can have electricity service, except those who cannot pay for the service. It can be said that most of the facilities for electricity are installed in the study areas.

ANNEX J :

WATER QUALITY IMPROVEMENT

CONTENTS

LIST OF TABLES

LIST OF FIGURES

J.1 Present condition of coffee production in Colombia

J.1.1 History of coffee production

1732: A coffee tree was cultivated in Santander province for the first time.

1910: Coffee cultivation spread in Antioquia province and Caludas province, which surpassed Santander in coffee production.

1920: Two million sacks (60kg of coffee in each sack) were exported from Colombia in total, and coffee became the best among exported products.

1980: According to the Coffee Census in 1980, coffee cultivation covered an area of 1,009,580 ha and the planted coffee in total amounted to 2,660,779,000 trees.

At present Colombia is the second largest coffee producing country in the world, and as to the production of mild coffee Colombia is the largest country.
Production of coffee in 1980 amounted to about twelve million sacks and about eleven million sacks were exported based on the survey by the Ministry of States U.S.A.

J.1.2 Coffee farm

Production of coffee in Colombia is operated by "mini fundios" (small scale farming) in fact, and the average cultivation area of each mini fundio is 3 ha, although the law of Colombia prohibit dividing 5 ha of farm yard into smaller size, but there are tendency that farm yards became smaller and smaller because of inheritance tax problems, etc.

As to number of farms is as follows.

Size of farm	%
1 ha or smaller	36%
1.1 ha – 10 ha	60%

The area of this 96% is equivalents to 57% of whole cultivated area of coffee in the country.

J.1.3 Cultivated variety

According to the recent questionnaire to farms on their cultivated varieties, its results is as follows.

Variety	(%)
Caturra	74.4
Tipica	63.5
Bourbon	12.2
Colombia	5.3

There are many farms adopting cultivation of mixed varieties.

Cafe-tecnificado covers 343,000 ha or more and yields five million cargas, Cafe-traditional covers 665,000 ha and yields 3.8 million cargas as shown in the census as of 1980.

: Cargas = 125 kg parchment coffee

J.1.4 Actual condition of cultivation

Nationwide coffee cultivation is performed under following conditions.

Elevation	2,000m - 200m
Average temperature	17°C - 23°C
Annual rainfall	1,500mm - 3,200mm

In addition to the above, the cultivation is carried out under Sueltos soil with high permeability containing abundant potassium, phosphate, nitrogen and line.

Cultivation area in the Crystales river basin is as follows.

Elevation	1,400m - 1,100m
Average temperature	21.9°C
Annual rainfall	2,000mm

The cultivation is performed at steep slopes of valley in the Crystales basin, where coffee cultivation is prosperous notably in Quindio province.

Coffee cultivation area is spread over the country, however, yield is small in Atlantico province, Sukle province, three direct jurisdictions (there are four direct jurisdictions), Sanandres Island and in five special districts.

Antioquia province is big yield province, producing five million sucks among twelve million sacks of the national total yield.

J.1.5 Cultivation method and varieties

Coffee cultivation is done by means of seedling propagation customarily.

Traditional varieties are cultivated by the following method.

Coffee beans of good quality in the farm are chosen and their seeds are taken out, washed and dried. After that, the seeds are sown onto germination beds made of river sand, etc.

About one month after sowing, the seeds grow into Fostorito and become Chaopola with leaves after two months.

The Chopola of good quality are chosen and transplanted onto small germination beds composed of soil mixed with composted pulp and grown up for six months to a stage called Plantura.

The Plantura is transplanted to farm yard and cultivated.
Two years after the transplantation, Plantura gets purutillas on its branches and blooms. Nine months after blooming, fruits ripen. The fruits are harvested carefully by hand without gloves.

It takes four years for regular harvest from sowing, and after then harvests can be done consecutively until the age of a tree reaches thirty years. During the period, Zoqueo is required at the sixth year and the eleventh year for quality control and trees are cut to 30cm high from the grand level. The yield is decreased this time temporarily.

Traditional varieties are El Bourbon, La Tipica and El Arabigo, which are sensitive against rust, require shadow cultivation. Compared with improved varieties, yield of traditional ones per unit area is about a half, 80 arrobas/ha/year and 190 arrobas/ha/year respectively, they say.

Caturra

This variety was spread in 1970's as an alternation of the traditional varieties. Characteristics of this variety are as follows:

- Cultivation without shadow is available. Traditional varieties are cultivated with shadow of guwamo or banana trees.
- Harvest can be done from tree age of 1.5 year. Commercial harvest period is 10 years the Zoque is done at 6th year only.
- Number of trees planted per unit area is about ten times of traditional varieties, 1 tree/m2 for Caturra and Colombia.
- While yield of traditional varieties is 400kg/ha/year, yield of this variety can be expected 2,000-2,500kg/ha/year.

Colombia

This variety is made by crossing Caturra with Robusta and strongly against the Roya.

J.1.6 Harvest and quality

Harvesting period varies according to regions over the country, but is done twice a year over the country in common.
Harvesting period in Quindio also varies according to difference in climatic conditions of each cultivation area based on difference of elevation of each area, which can be said also in Armenia where the elevation varies from 1,100m to 1,400m. In Armenia, area where the elevation is about 1,200m, main crop Cosesha begins from September to the end of a year and Travieza from March to April. In highland this situation is inverted. The delicate difference in commencement time for harvest of coffee is based on the relationship between rainfall and the maturity of fruit. In the feasibility study survey, 1990, the rainfall was small and harvest scheduled to commence on August was delayed to the beginning of September.

Table J.1.6 shows the difference of harvest seasons in Colombia.

Table J.1.6 Harvest seasons

Local name	Cosecha	Travieza
1. Magdalena	11 - 1	
2. Norte de Santander	3 - 5	10 - 12
3. Antioquia	10 - 1	3 - 5
4. Santander	8 - 10	
5. Norte de Caldas	10 - 12	4 - 6
6. Sur de Caldas	3 - 5	10 - 12
7. Cundinamarea	4 - 6	10 - 12
8. Huila	4 - 6	10 - 12
9. Tolima	3 - 6	11 - 1
10. Valle del Cauca	3 - 5	9 - 12
11. Cauca	4 - 6	12 - 2
12. Narino	5 - 7	1 - 2
13. Boyaca	6 - 7	10

Quality

As to quality, coffee beans are classified by their size for exportation

1) Superemo — Percentage of beans bigger than screen 17 is 80% without strange solids, the colour is bluish green, which is the highest quality.

2) Excelso — The size is screen 14-16, the standard quality.

3) Others — Coffee beans with size below screen 14 are consumed domestically.

J.1.7 Amount of production (1986)

Amount of coffee production occupies 17.3% of the total crop production of Colombia, and amounts to 720,000 ton which is 15.5% of the total coffee production of the world.

Coffee production in Quindio occupies 8.9% of the total coffee production in the country, and its yield per unit area is the number 1 in Colombia.

Table J.1.7 Coffee production in Colombia and study area

Parameter	Country	Quindio		Studied area (Crystales basin)	
Cultivated area (Ha)		65.690	6.1	7.095	10.8
Amount production (T/Year)	763.325	67.936	8.9	17.012	17.4
Yield per unit area (T/ha)		1.49		2.40	

J.1.8 Production of coffee beans

Colombia adopts wet purification method which is also adopted by almost all of mild coffee producing countries.
Harvested coffee fruits are processed within the harvested day for the maintenance of quality. Generally, coffee fruits are harvested day time, and stocked in fermentation tank at 4 - 7 P.M.

The fermentation is completed after about twelve hours, early in the next morning, 4-8 A.M., then the coffee fruits are washed. Mild and oily substance adhering to the fruits are removed easily by washing after the fermentation is completed. Prolonged fermentation changes the colour of coffee beans and degrades their quality, therefore, the duration of fermentation shall not be longer than 24 hours.

Thus, washing water, that is, coffee processing waste water, is emitted and flows into river intensively at early in mornings.

After that, quality classification by washing is done and Pasillo is removed from coffee beans, then the beans are dried by Elva. In large scale farms and in intensive processing plant coffee beans are dried by forced hot blows.

Dried coffee beans have thin Sisco and become articles of trade as Pergamino Seco are dealt in markets. Pergamino is thrashed by makers concerned and Sisco is sent mainly to brick makers as fuel.

As to manpower, almost all of farms depend on Arroberos. For example in the busiest period of harvesting, a farm of 35 ha scale can collect about one hundred labours, they say.

At present coffee is overstocked and some of farms consent to changing crops.

J.1.9 Income of coffee farm

J.1.9.1 Profit of coffee production

1) Caturra and Colombia	558,000	Col$/Ha
2) Tradicional	172,000	"
3) Platano	44,000	"

(Caja Agraria - 1989)

J.1.9.2 Income of coffee farm in Armenia

1) Harvest per Ha of average scale farm
180 @ pergamino seco/Ha
(180 @ = 2,250kg)

2) Production cost
Cost of cherry harvesting 330,000 Col$/Ha/year
(cherry collection, fertilizing & routine maintenance)

Cost of processing 2,100/@
(Depulp, Fermentation, Washing & Drying)

3) Price of marketable coffee 7,500/@

4) Cost calculation

a) Farms profit per year

180 @ x 7,500 = 1,359,000

b) Annual production cost

180 @ x 2,100 + 330,000 = 708,000

c) Gross profit [a) – b)]

1,359,000 – 708,000 = 651,000

d) An earning rate

47.9%

The above excluding from land cost, financial cost, and technical supervising fee.

J.1.10 Farmer's Organization

J.1.10.1 Cafe Comite

Cafe Comite is situated under the FEDECAFE in order to promote agricultural development to coffee farms.

J.1.10.2 FEDECAFE

Federacion Nacional de Cafeteros de Colombia was established as private organization which contracted for the control of coffee market between Colombia government in 1972.

J.1.10.3 CENICAFE

El Centro National de Investigacions de Cafe is located in Caldas Cincina.
This organization is world wide famous for coffee technologies.

J.2 Coffee Waste Water

J.2.1 Waste water quantity

J.2.1.1 Waste water quality of fermented beans washing waste water

Table J.2.1.1 Fermented washing waste water quality (in reference)

Item	CRQ	CVC	CENICAFE	HORTON
BOD_5	10,500 – 15,538			295 – 3,600
CODcr	17,910 – 22,643		3,385	
SS	2,073 – 3,170		55	235 – 2,385
SD	6,262 – 10,111		2,232	650 – 755
pH			4.4	4.1 – 5.5

J.2.1.2 The result of water analysis of small scale centralized coffee processing factory La Aurora - Armenia.

Table J.2.1.2 The result of La Aurora (Mixed waste water)

Item	1989 Nov-6	1989 Nov-12	1989 Nov-19	1989 Nov-26	1989 Nov-27	1989 Nov-27
BOD_5	3,030		2,730	1,030	1,200	6,160
CODcr	5,800	7,250	4,010	1,710	2,210	8,930
Acidity	220	190	220	120	150	200
T.S	2,750	4,090	4,750	1,190	1,130	4,630
NH_4—N						17
P	1.9	3.3	3.9	2.8	2.3	2.4
pH	3.96	4.04	3.96	4.10	4.03	4.49

J.2.1.3 The waste water analysis of coffee farms in the Cristales.

Table J.2.1.3 Result of analysis

Name of farm / Item	El Rocio 9/13-1990	Sebastopol 9/13-1990	El Rocio 10/10-1990	Sebastopol 10/10-1990
CODcr	12,250	12,540	22,120	3,940
(Filter)	(11,450)	(9,530)		
SS	1,620	1,120	2,380	380
Turbidity	1,825	2,500	2,000	210
Acidity	1,600	1,900	1,200	210
T.S	10,380	10,900	25,310	3,190
pH	3.38	3.59	4.39	4.55
BOD			17,330	2,355

J.2.1.4 Depulping waste water

Depulping waste water generates from the process of depulping with a great amount of water for cherry transportation from Tolva to depulpadoras. The waste water quality of depulping is fundamentally different from fermented washing waste water.
Another vicious waste water from depulp is an extracted coffee pulp juice from whether beaten pulp and rain-fall.

Table J.2.1.4 Depulping waste water quality

Item	CRQ	CVC	CENICAFE	HORTON
BOD_5	1,560 – 9,870			3,280 – 15,000
CODcr	4,819 – 16,320	416 – 36,000	8,150	
SS	532 – 5,435		449	625 – 1,055
SD	1,624 – 9,789		3,211	9,465 – 11,285
pH		3.5 – 4.0	5.0	4.1 – 4.4

J.2.1.5 Mixed waste water quality

Mixed waste water means the mixture of depulped waste water, fermentation pit waste water, fermented waste water and miscellaneous used waste water.
Several waste water analysis results are shown Table J.2.2.6.

Table J.2.1.5 Mixed waste water quality

Item	C. R. Q.				Pisaralda	Aurora
	A	B	C	D		
Date	5/10-'80	8/12-'80	8/28-'80	7/6-'79	4/9-'90	4/18-'90
Color			1,800	600	525	180
Acidity	3,690	2,260	2,220	1,550	195	2,640
Fe	5.9	6.8	2.2			
NH_3-N	36.6	11.1	6.8	4.2	8.2	
NO_2-N	0.00	0.01	0.02			
NO_3-N	0.15	0.6	0.15			
Kj-N	16.2	7.6	10.5		214	
Cl		110				
P	12.4	12.1	5.1		12.5	14.0
BOD_5	12,300	6,900	12,600	12,250	9,460	34,970
CODcr	22,640	10,368	14,896	21,120	12,262	
MPN/100ml	46×10^3	3.6×10^9				
T.S	8,143	5,658	7,210	14,490		
I. Loss	6,577	4,919	5,932			
S.S	3,138	2,901	1,854			
V.S.S	3,016	2,825	1,638			
pH	3.4	3.5	3.7	3.77	4.7	3.52
Turbidity				450	525	1,200

* Tratamiento Residuous Liquidos Beneficio del Cafe.
C.R.Q. Labo

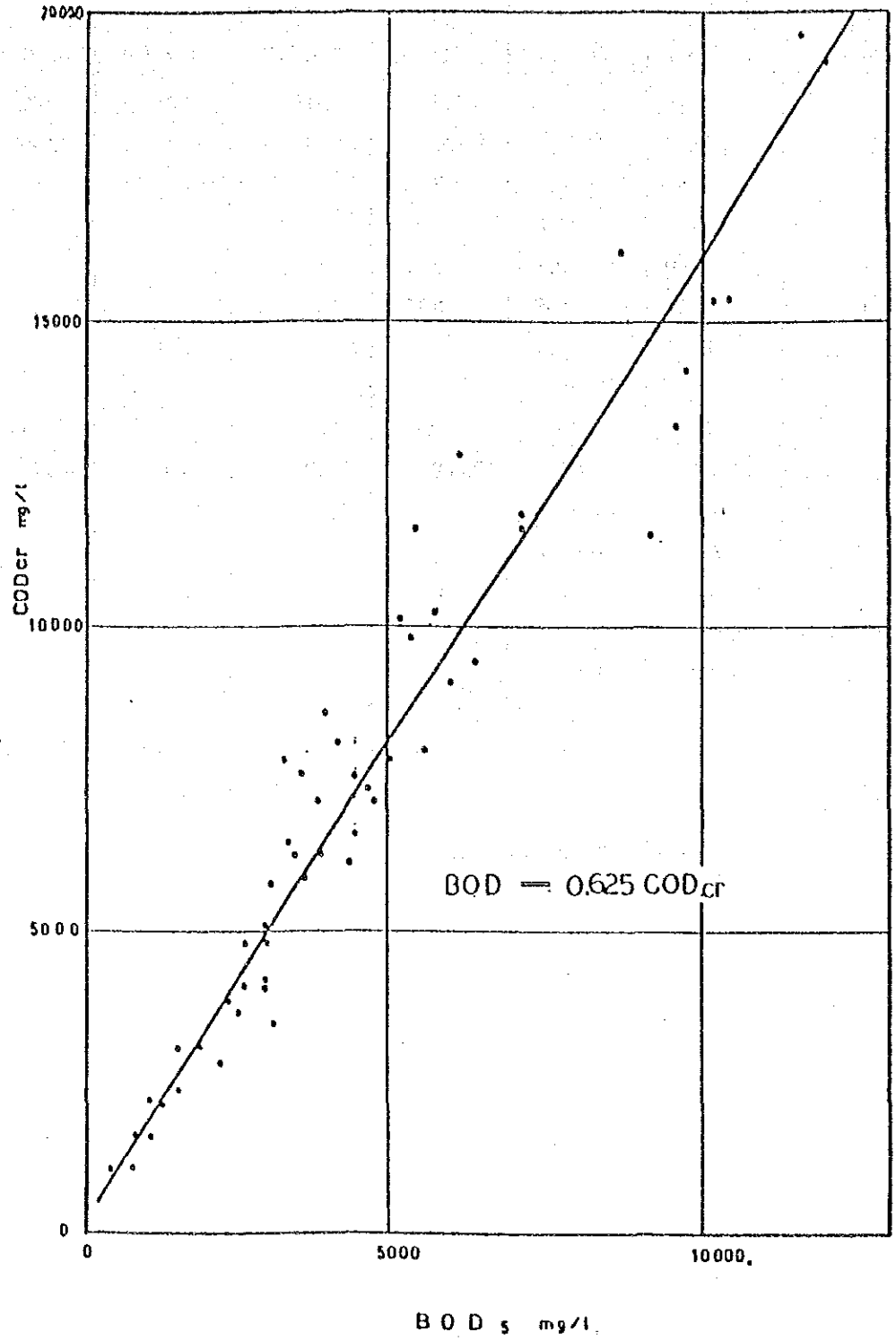


Fig. J.2.1.1 Correlation between CODcr-BOD_5 Volume of Coffee Waste Water

J.2.2 Quantity of waste water

J.2.2.1 General

Waste water quantity from coffee processing is different with its processing method and worker's experiential judgement of water consumption.
According to our study farms may divide based on the water consumption. They are

a) Few water consumption relatively 8 – 10l/kg - coffee
b) Average water consumption 15 – 30l/kg - coffee
c) Large water consumption at big scale farms and centralized processing factories 80 – 100l/kg - coffee

J.2.2.2 Experimental result I

Small scale centralized processing factory La Aurora 4 days continuous measurement results as follow.

Table J.2.2.2 Experimental Result I

Date	Coffee production	Water consumption	Water/Coffee
1990 – 4 – 24	106 Gal (330kg)	4,000 l	12.12 l
4 25	94 " (293 ")	4,420 l	15.1 l
4 26	88 " (275 ")	4,100 l	14.9 l
4 27	62 " (194 ")	7,950 l	41.0 l
		Average	20.78 l

1 gal = 1 @ = 12.5 kg

J.2.2.3 Experimental result II

Experimental waste water analysis at farms in the Cristales alto.

Table J.2.2.3 Experimental Result II

Farms	River	Coffee cultivation	Water consumption
La Herrera	Q. Erlin	28 Ha	23.5 l/kg – Coffee
La Esperanza	Q. Erlin	24 Ha	(1) 14.19 l/kg "
			(2) 21.50 l/kg "
			(3) 17.30 l/kg "
La Holanda	Q. Erlin	35 Ha	(1) 23.03 /kg "
			(2) 13.56 l/kg "
			(3) 11.0 l/kg "
			(4) 30.8 l/kg "
La Mesa	Q. Erlin	28 Ha	(1) 8.1 l/kg "
			(2) 9.4 l/kg "
La Mesita	Q. Erlin	7 Ha	16.8 l/kg "
	Average		17.2 l/kg – "

(C.R.Q.)

J.2.2.4 Experimental result III

Experimental waste water analysis at a large scale centralized coffee factory "Pisaralda".

Table J.2.2.4 Experimental Result III

Date	Coffee production		Water/Coffee
1990 – 8	120 @ (1,500kg)		
	1st washing	12,800 l	8.53 l
	2nd washing	12,800 l	8.53 l
		25,600 l	17.06 l/kg – coffee

Water consumption was measured fermened beans washing water only.

J.2.2.5 Reported water consumption

Table J.2.2.5 Reported result

Reporter		Water consumption			
1) T.W. Brandon	England (Kenya)	51.3	–	76	l/kg
2) R.A. Orozeo	Costarica	17	–		l/kg
3) G.A. de Leon	Costarica	8	–	25	l/kg
4) R.K. Horton	El Salvador	8.3	–	21.3	l/kg
5) M. Morua	Costarica	22	–	44	l/kg
6) F. Maya	CRQ Colombia	30	–	40	l/kg
7) J.J. Torres	CRQ Colombia	100			l/kg
8) Federation de Cafeteros de Colombia		20			l/kg

J.2.2.6 Average water consumption

The result of water quantity experiment of the Cristales area should be made much more:

The water consumptions are;

Daily average	22.5 l/kg-coffee
Daily maximum	30 l/kg-coffee

The above mentioned numbers will be applied to a designing criteria generally.

J.2.3 Coffee processing methods in the Cristales area

If different types coffee processing method which are using in the Cristales area are introduced in Fig J.2.3.1 – (1)~ (2).

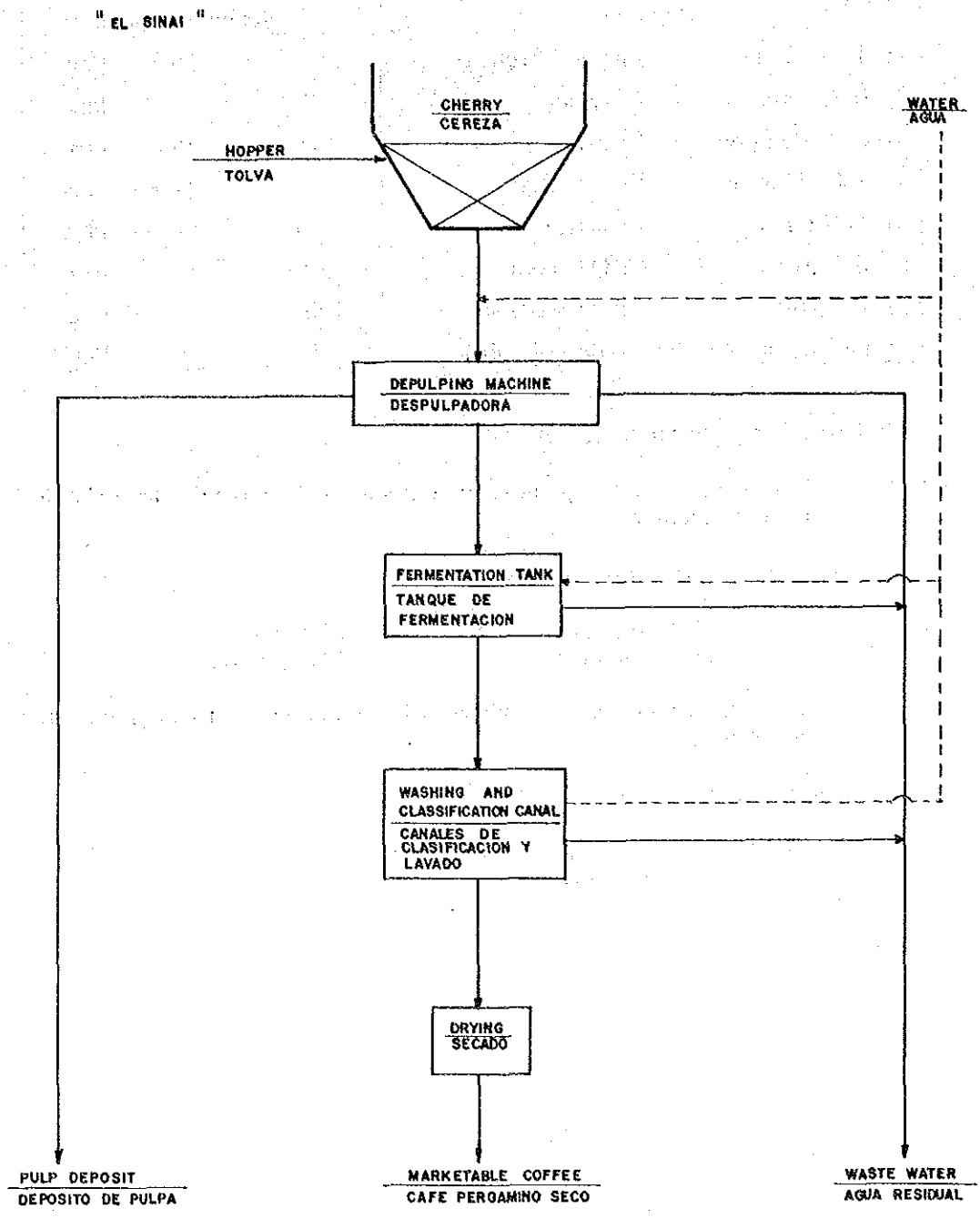


Fig. J.2.3.1(1) Various Type Coffee Processing

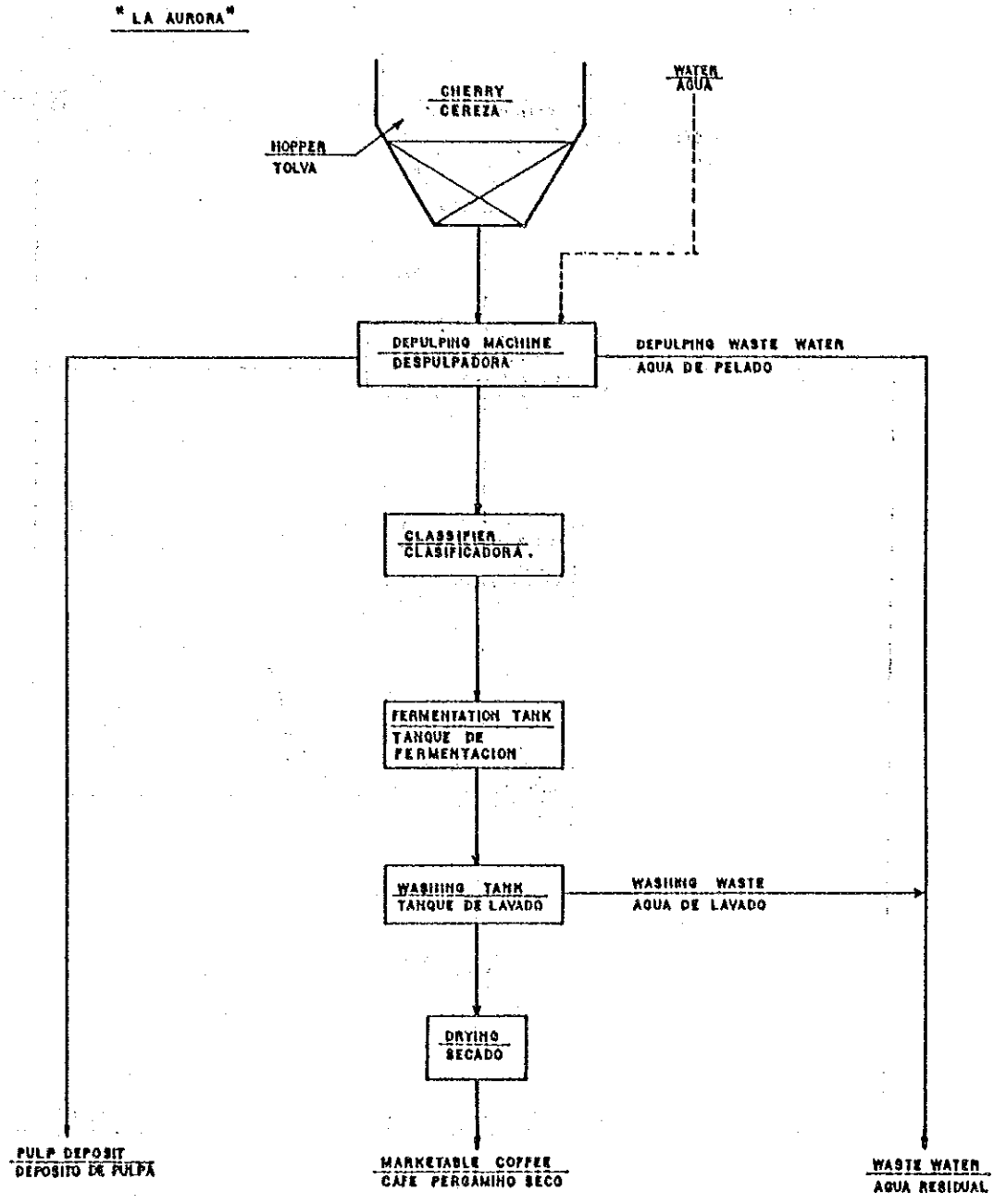


Fig. J.2.3.1(2) Various Type Coffee Processing

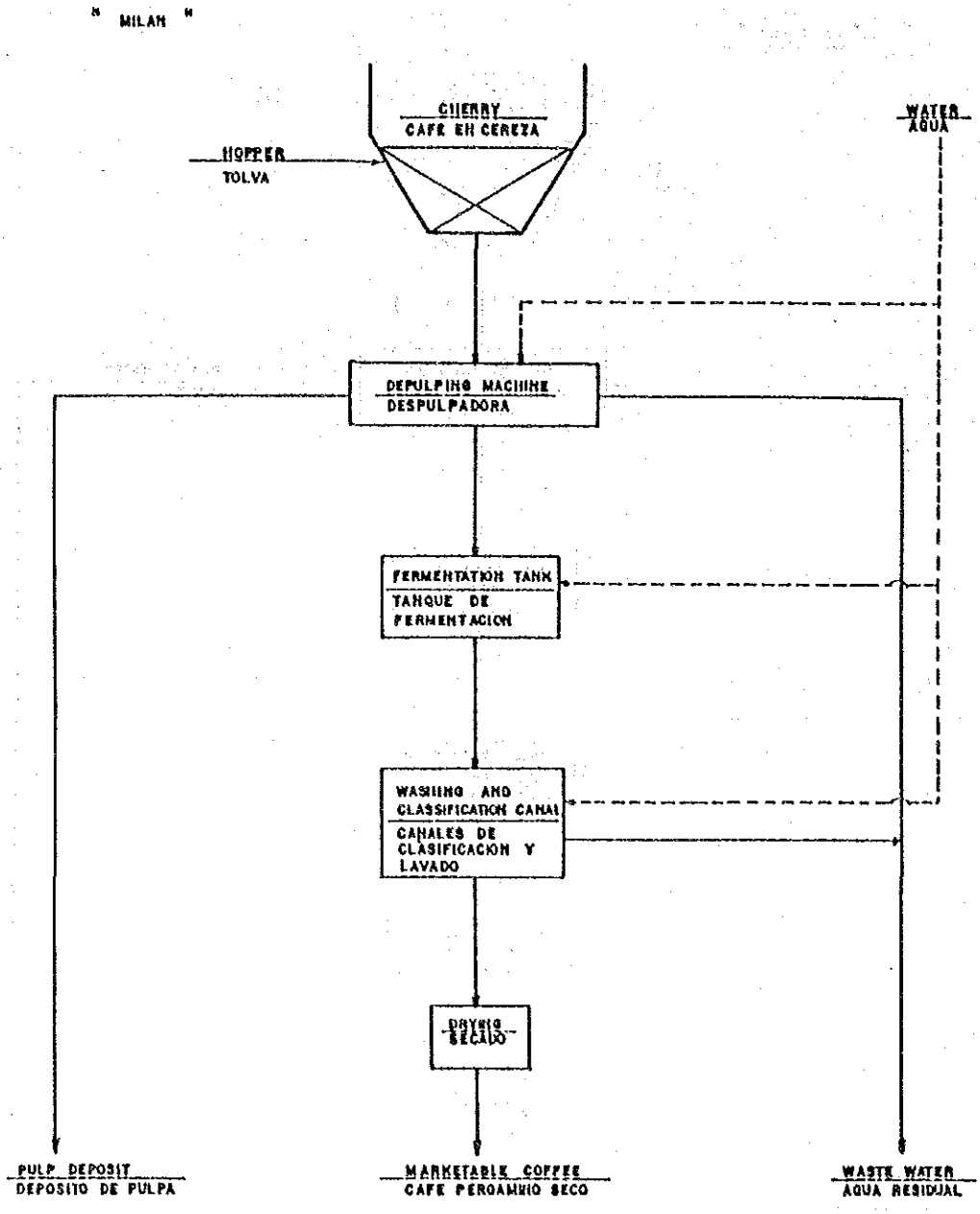


Fig. J.2.3.1(3) Various Type Coffee Processing

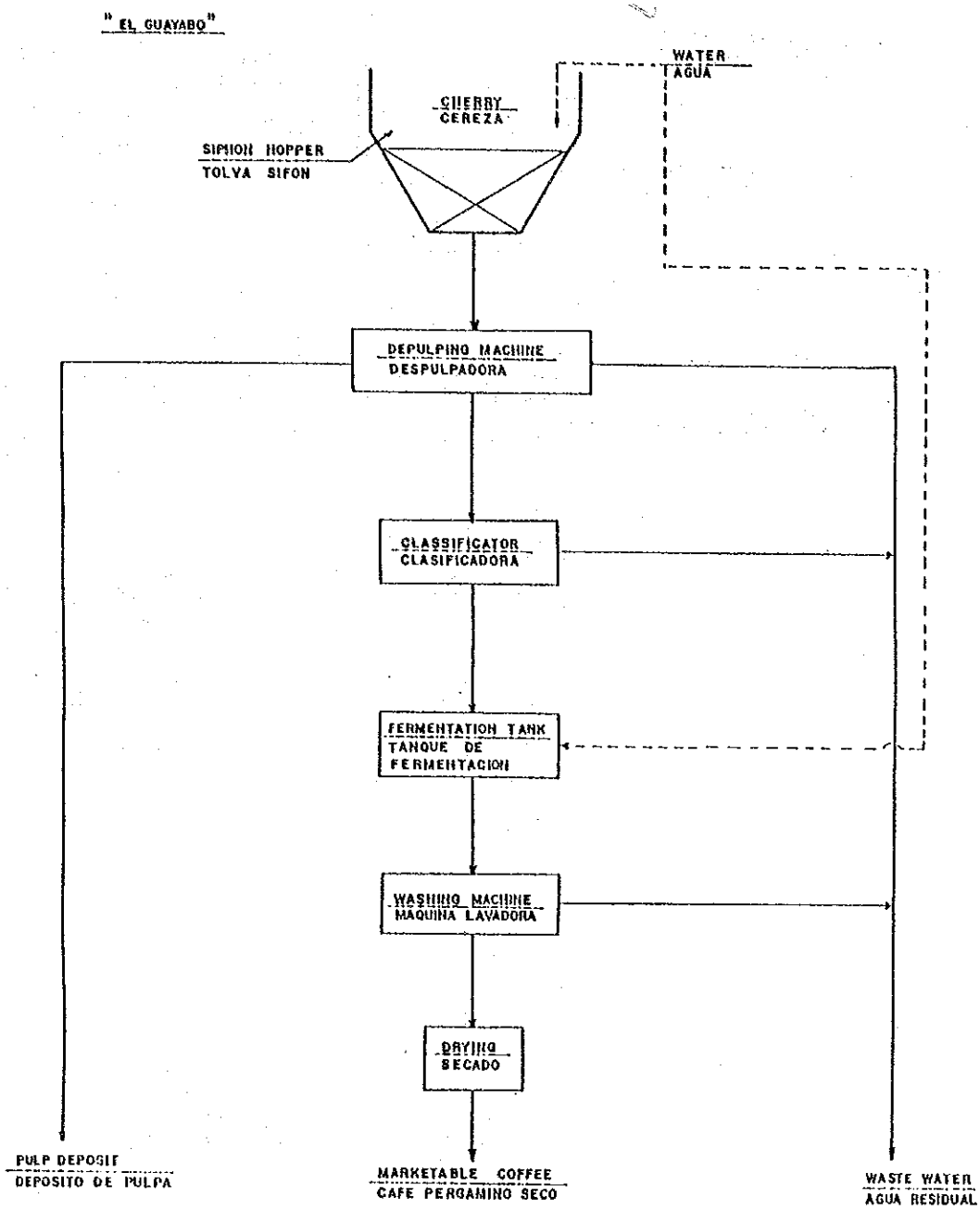


Fig. J.2.3.1(4) Various Type Coffee Processing

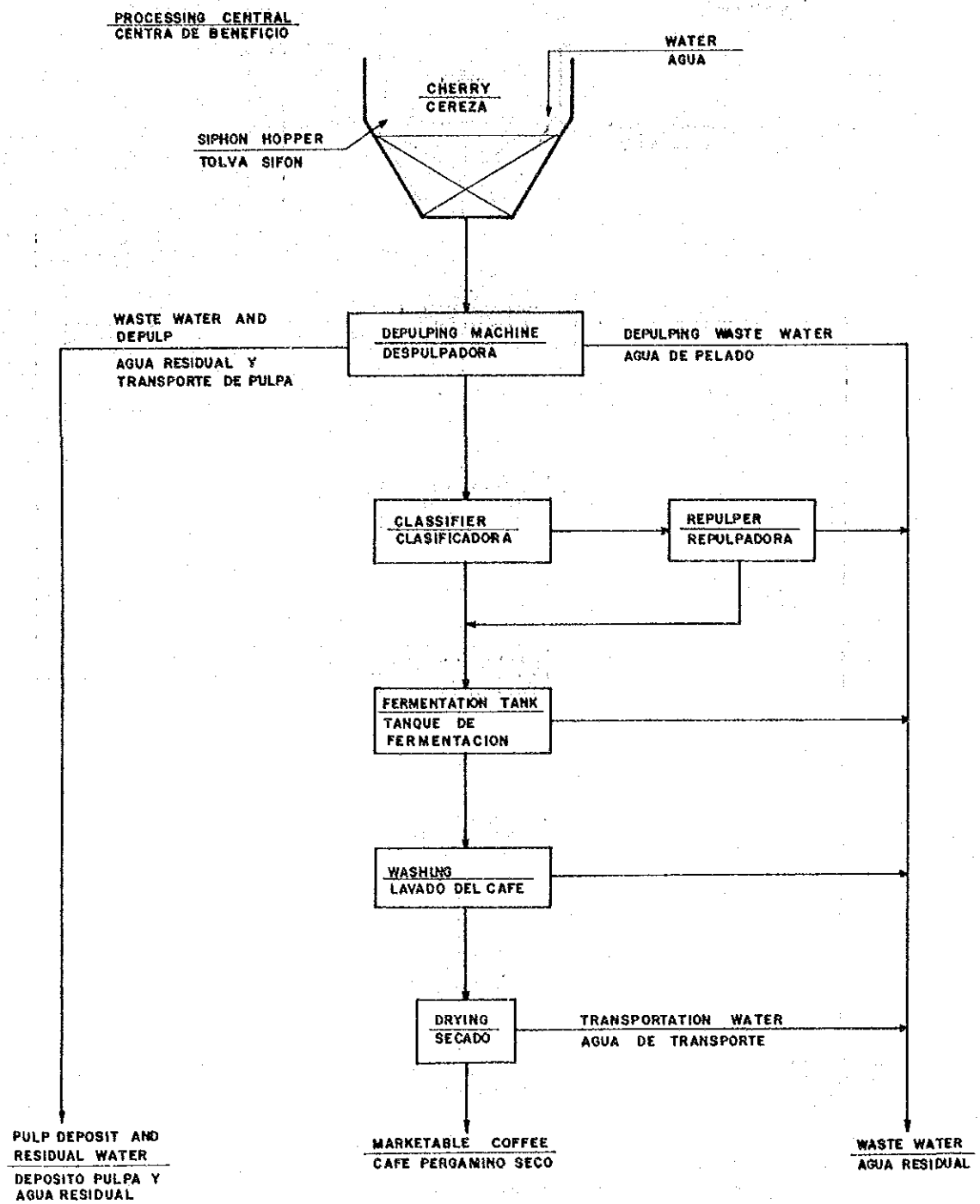


Fig. J.2.3.1(5) Various Type Coffee Processing

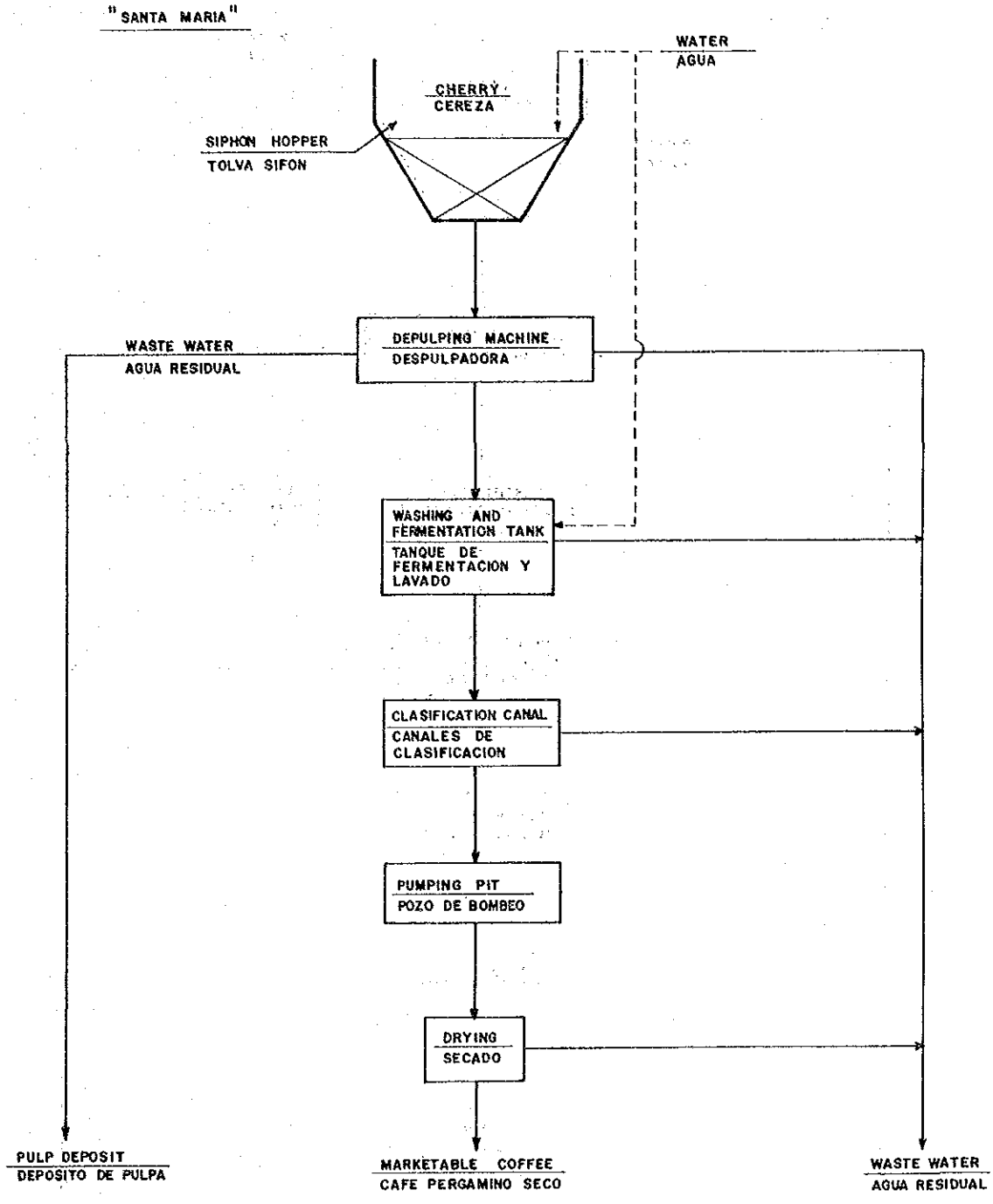


Fig. J.2.3.1(6) Various Type Coffee Processing

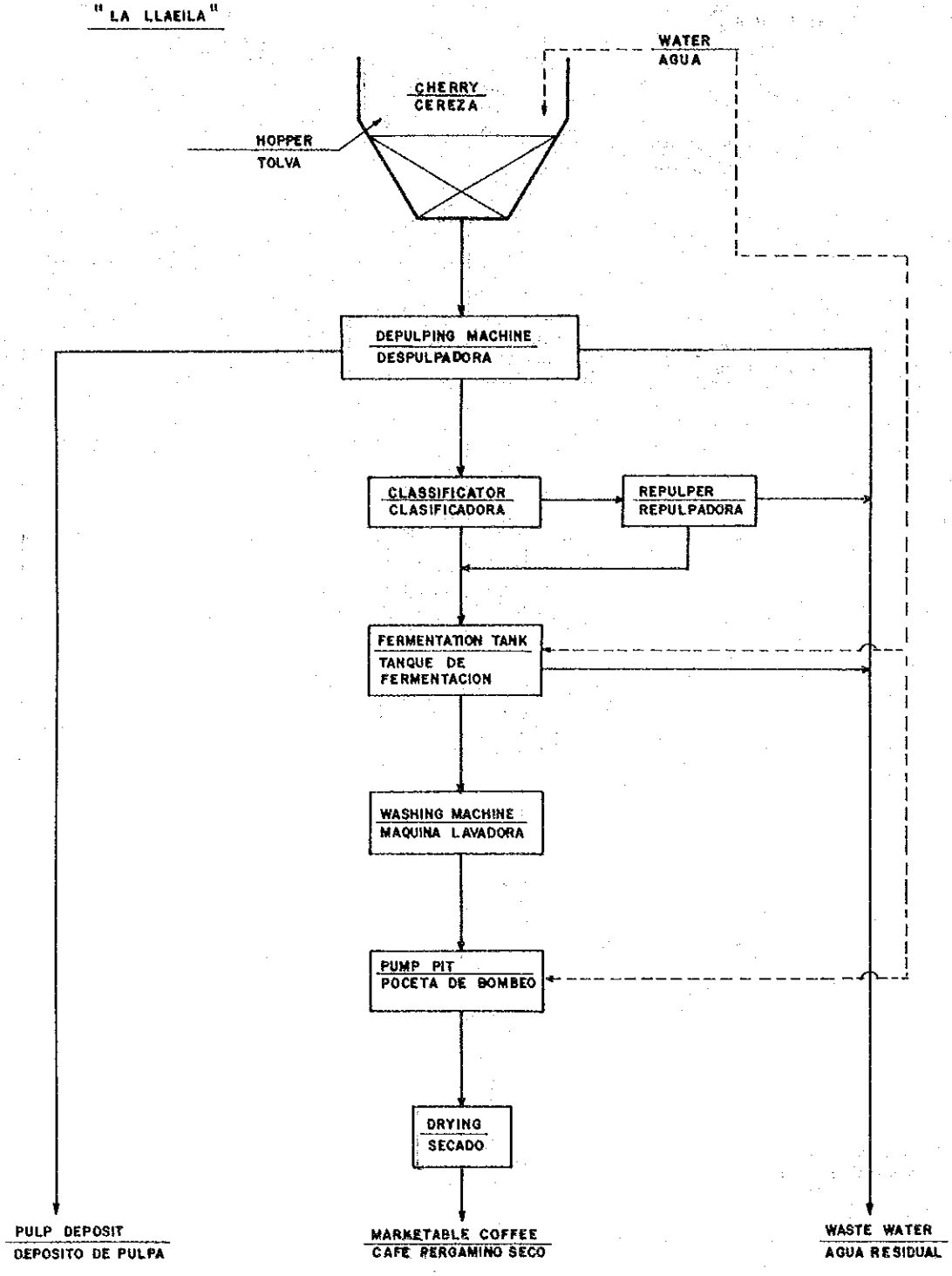


Fig. J.2.3.1(7) Various Type Coffee Processing

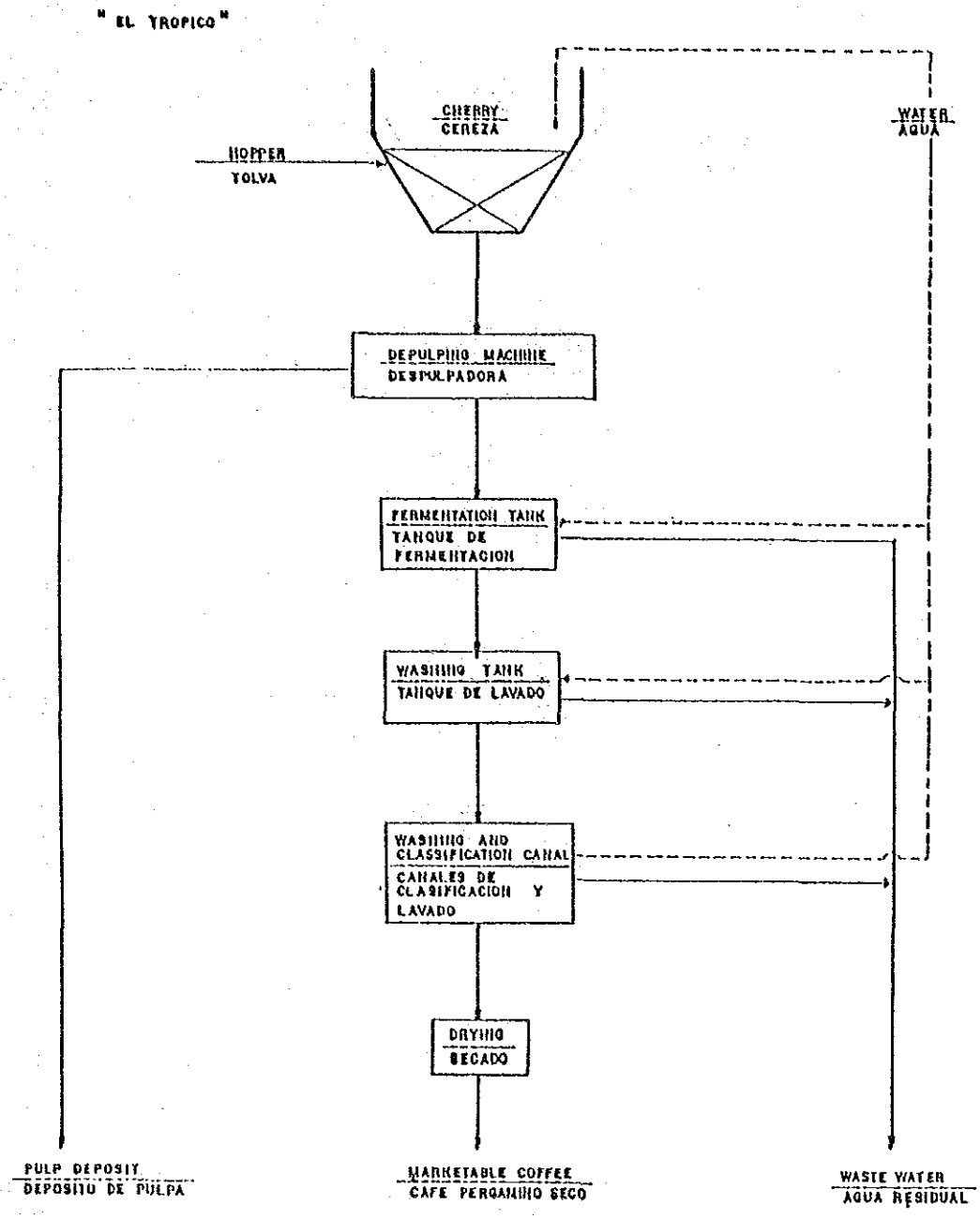


Fig. J.2.3.1(8) Various Type Coffee Processing

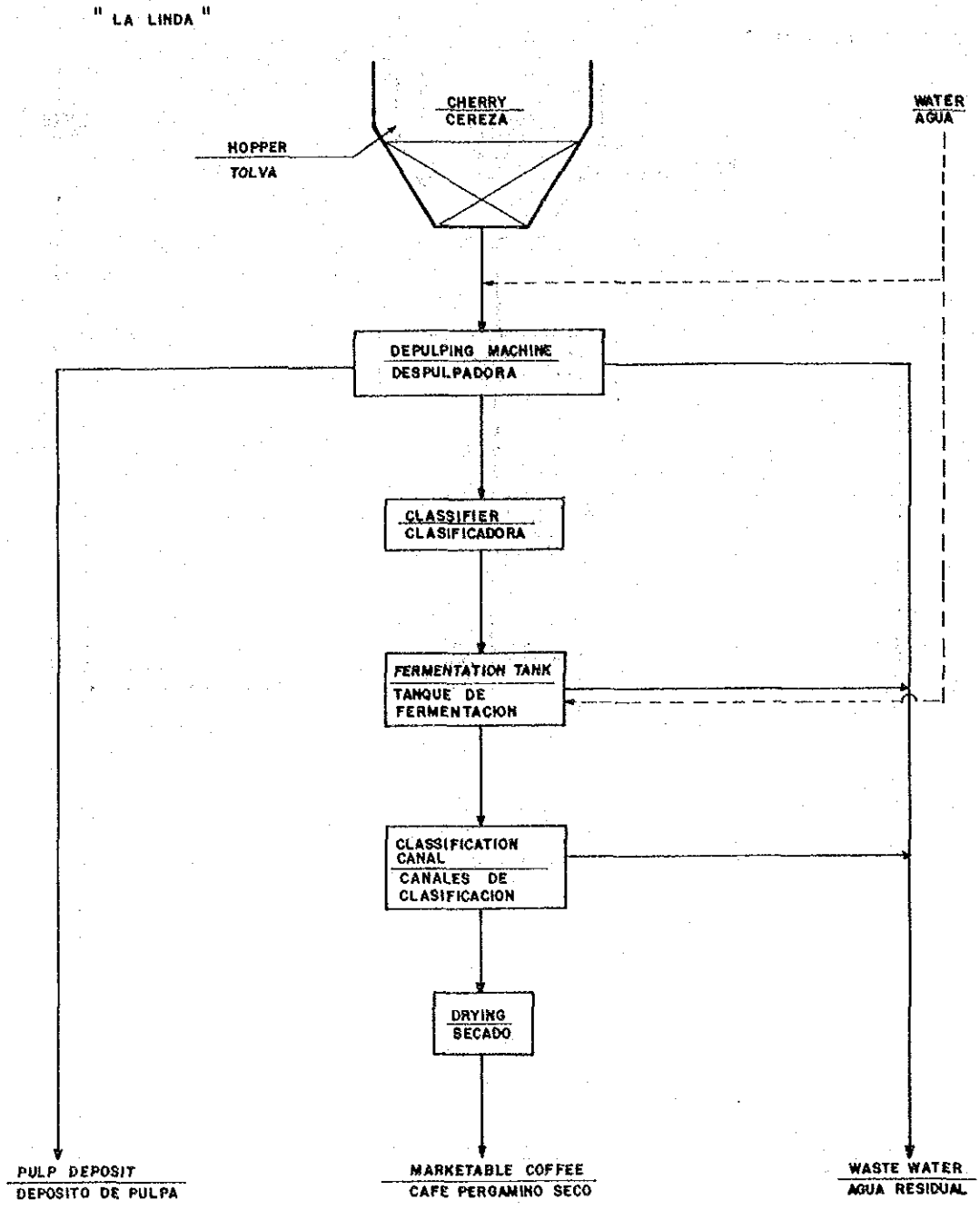


Fig. J.2.3.1(9) Various Type Coffee Processing

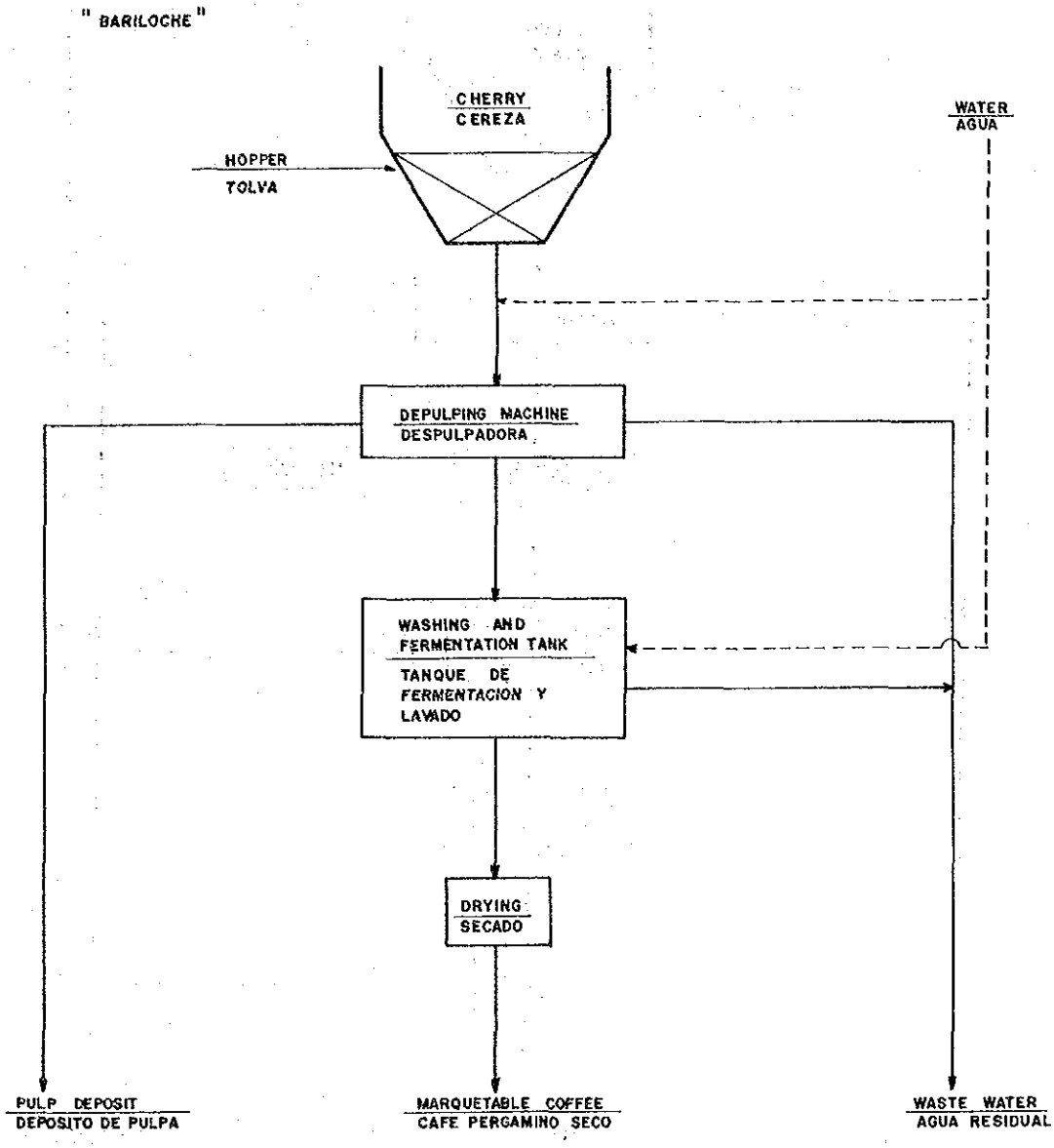


Fig. J.2.3.1(10) Various Type Coffee Processing

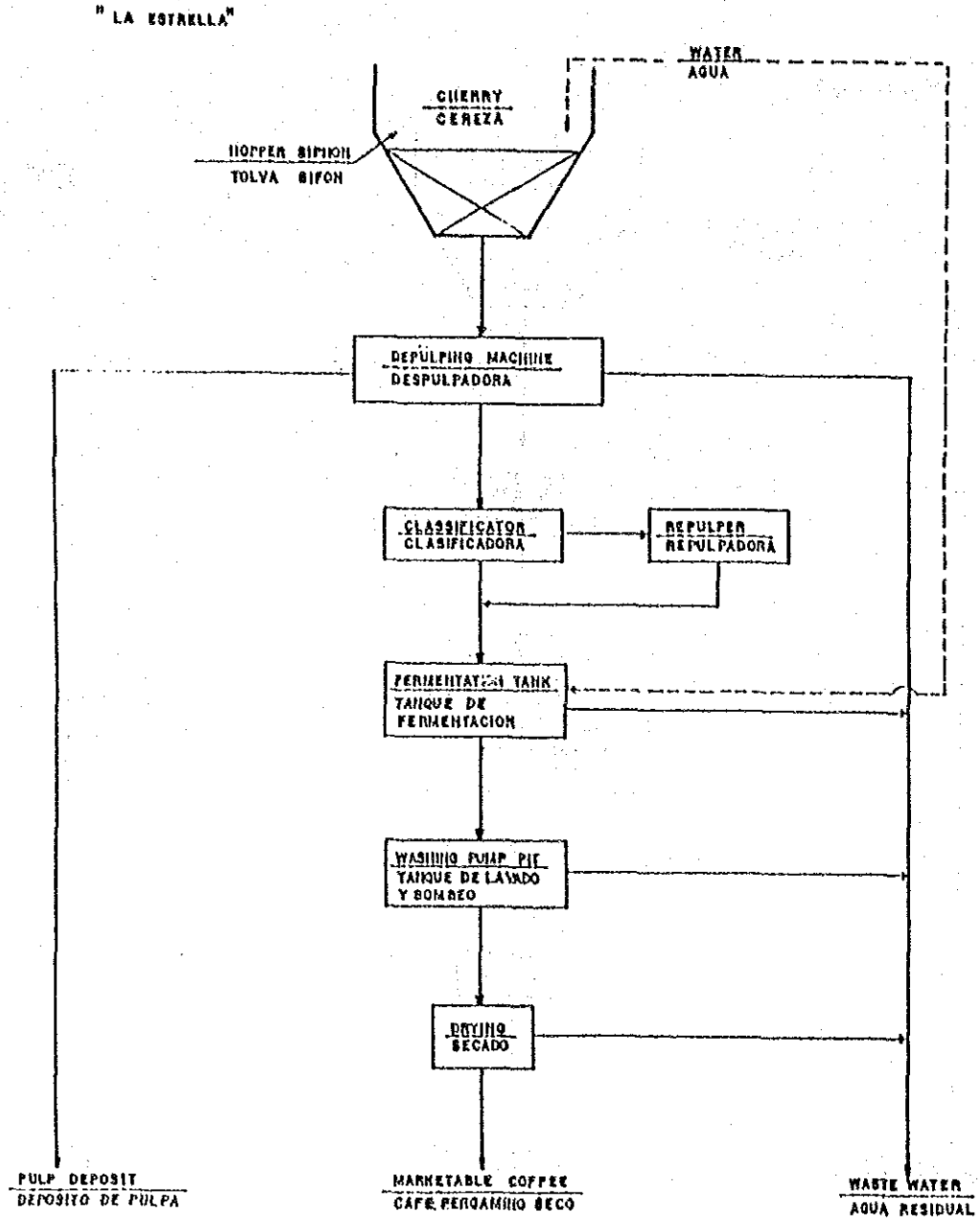


Fig. J.2.3.1(11) Various Type Coffee Processing

J.2.4 Pulp

J.2.4.1 General information of coffee cherry (CENICAFE)

1. One cubic meter of cherry mature coffee, weight 600 kilograms.
2. One cubic meter of recently depulping coffee, weights 800kg.
3. One cubic meter of fresh pulp without flattening, weights 420kg.
4. One m^3 of fresh pulp without damping, weights 270kg.
5. One m^3 of wet coffee, weights 650kg.
6. One m^3 of dryed coffee of water weights 520kg.
7. One m^3 of dryed coffee beans hulls, weights 380kg.
8. One m^3 of coffee bean, weights 680kg.
9. 1,000kg of berry mature coffee give 400kg of pulp and 600kg of recently despulping coffee (222kg of dryed coffee beans hulls).
10. 1,000kg of recently washed coffee beans hulls, give 790kg of dryed of water coffee beans hulls.

J.2.4.2 Chemical composition of pulp

The pulp consist of 88% of fruit and 12% of water. Chemical composition of drying pulp is as follow.

Table J.2.4.2 Chemical composition

Chemical	Value
Protein	15%
Fat	1 - 3%
Ash	8%
Caffeine	1 - 2%
Calcium	0.15%
Tannin	5.0%
K	3 - 5.5%
Cellulose	54%
Cellulose	
Semi-cellulose	
Pectin	
Others	a small amount
Tannic acid	
Poly phenol	

(CRQ)

J.2.4.3 Depulped waste water

1) Depulped waste water quality

Table J.2.4.3 Depulped waste water quality

Item	Value (Average)
pH	4.3
Acidity	150 mg/l
BOD_5	8,150 mg/l
Color	1,300
SS	1,600 mg/l
T.S	10,380 mg/l
Cl	0.8 mg/l
Tannin	177 mg/l

2) The fresh pulp is transferred to simple bamboo made silos or leave to the whether near farms then they are able to apply to coffee farms as a fertilizer.

3) New bad quality waste water is generated from weather beaten pulp with rain water and miscellaneous water.

J.2.4.4 Utilization of the pulp

In the field of coffee production technologies, the utilization of waste pulp is one of important subject and behind development too.

1) Returning to the agricultural farm land as fertilizer is the most useful method in this area.

: Direct fertilization to coffee farms
: Fertilization to new cultivated land
: Mixed fertilization to Coscara

2) Feed to fresh water fish breeding

3) Fooder to cattles

4) Items of further development manufacturing of alcohol extract of pectin etc.

J.3 Present aquatic environmental situation affected by waste water in Quindio

J.3.1 River polluting factors

1. Coffee processing waste water
2. Sewage
3. Waste water from other agricultural processing industries

   a) Beer brewing
   b) Butcheries and meat processing industries
   c) Stock breeding

J.3.2 Loads of river polluting factors

1) Annual coffee production is 97,936 ton and estimated minimum waste water is 979,360m^3, and the organic matter contained is equal to 9,793 ton/year of BOD.

2) Total population in Quindio is 360,000 and estimated average sewage is 26,280,000m^3, and the organic matter contained is equal to 5,256 ton/year of BOD.

3) As to beer brewing, there is a small scale factory in Armenia. Polluting load is not clear, but the waste water is discharged into sewer in Armenia without treatment.

4) There are butcheries in each city in Quindio. The butcheries in Quindio are located along the Quindio river and great amount of blood, etc. are discharged.

5) Stockbreeding mainly consists of cattle grazing and pig breeding and most of cowhouses are located along rivers, and excretions of animals and water for washing animal houses are discharged into rivers.

6) Discussion

   As to load of coffee processing waste water, investigation all over Quindio has not been performed, therefore, estimated minimum value was adopted to it, and estimated average value was adopted for daily drainage, however, the load of coffee waste water is considered to be at least twice as heavy as that of daily drainage.

J.3.3 Pattern of rivers pollution

1) Pattern of pollution by coffee waste water is seasonal and concentrated on the period which is one third of a year. Fruits of coffee ripen during the rainy season when the water flow of rivers is high in general, therefore, the water flow of rivers is high when coffee waste water is discharged.

2) Sewage is discharged throughout a year without treatment for contained organic matters, for improving bad appearance of foaming caused by detergent, etc., and for bacterium and escherichia coli, which cause epidemic diseases.

3) As to waste water from agricultural products processing industries, waste water from beer breweries is discharged with a great deal throughout a year with high concentration of organic matters, therefore this waste water should be a subject for further studies.

4) In almost all of rivers, high coefficient of the self purification of nature is expected at shallow mountain streams.

J.3.4 Investigation on consciousness of inhabitants in the prefecture about water quality conservation.

The result of questionnaires to leaders and engineers of 50 persons on coffee waste water is as follows in order.

1. Enlightenment education for water quality conservation
2. Studies on economical methods for treatment
3. Usage of rind and sarcocarp of coffee
4. Introduction of intensive treatment method
5. Lack of good treatment methods

J.3.5 Present situation of disease caused by water quality

Harvest season of coffee is rainy period, and according to the report by Quindio prefectural hospital there are two peaks in the number of cases of disease correspondent to the two peaks of coffee production.

J.3.6 Meteorological conditions in Cristales basin

Meteorological conditions in Cristales basin which influence the treatment of coffee processing waste water are as follows.

1)	Temperature	An average temperature of 20°C can be expected, which is convenient for the biological treatment.
2)	Insolation duration, evaporation	Insolation duration longer than 130 hrs/month and evaporation of 88mm/month are expected, which is convenient for the sludge drying bed.
3)	Precipitation	Monthly precipitation varies from 140mm/month to 280mm/month, which is convenient for oxygen supply to the stabilization pond with aquatic plants.

Some meteorological data at La Tebaida in 1990 are as follows.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.
Precipitation m/m	127.8	98.0	197.4	231.8	98.7	53.7	120.0	76.0
Days of precipitation	13	10	11	14	11	8	6	7

Meteorological condition

Meteorological conditions at Estacion El Eden (EL. 1204m) are as follows.

Table J.3.6.1 Meteorological Data in Cristales Basin

Item \ Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Temperature												
Maximum	31.2	31.0	31.6	30.8	30.3	30.2	31.2	31.7	31.0	30.5	29.8	30.8
Average	22.0	22.2	22.3	21.8	21.9	21.9	23.2	21.9	21.3	21.3	21.2	21.7
Minimum	12.2	13.0	13.0	12.2	14.0	13.3	12.6	12.4	13.5	12.6	13.3	13.1
Precipitation												
Average m/m	119	138	176	235	212	134	96	115	168	240	283	150
Insolation duration, Hrs	199	164	150	134	133	148	183	170	144	139	138	162
Relative Humidity %	78	79	78	82	82	81	78	78	79	82	82	81
Evaporation m/m	90	105	105	72	93	72	100	95	95	84	70	78

Meteorological conditions which affect waste water treatment facilities are as follows.

1) Temperature — An average temperature of 20°C can be expected, which is convenient for the biological treatment.

2) Insolation duration, evaporation — Insolation duration longer than 130 hrs/month and evaporation of 88mm/month are expected, which is convenient for the sludge drying bed.

3) Precipitation — Monthly precipitation varies from 140mm/month to 280mm/month, which is convenient for oxygen supply to the stabilization pond with aquatic plants.

Table J.3.6.2 Specific Discharge in Cristales Basin

(L/Sec/km^2)

Month	Return Period			
	1/2	1/3	1/5	1/10
Jan.	25.80	20.07	14.81	11.22
Feb.	25.97	20.22	14.91	11.30
Mar.	22.29	17.35	12.80	9.70
Apr.	27.12	21.11	15.57	11.80
May	30.74	23.93	17.65	13.37
Jun.	23.39	18.20	13.43	10.17
Jul.	15.68	12.21	9.00	6.82
Aug.	12.00	9.34	6.89	5.22
Sep.	11.56	9.00	6.64	5.03
Oct.	15.72	12.24	9.03	6.84
Nov.	33.30	25.92	19.12	14.49
Dec.	31.49	24.51	18.08	13.70