EL IMPACTO EN LATINOAMERICA DE LAS VARIEDADES DE ARROZ DE ALTOS RENDIMIENTOS, CON ENFASIS EN EL CASO COLOMBIANO

Resumen y Resultados para Discusión*

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* Basados en el Informe Preliminar, copias disponibles a petición.

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1. Este estudio fué iniciado a petición de la Junta Directiva del CIAT con el objeto de documentar y analizar: i) la contribución de las variedades de altos rendimientos (HYV's) en América Latina; ii) el tamaño y la distribución de los beneficios económicos derivados de la introducción de las nuevas variedades de arroz en Colombia.

2. En 1974 se sembró en latinoamérica cerca del 12 por ciento del área con arroz (800.000 Has) con nuevas variedades (HYV's).

3. La producción de arroz en latinoamérica fué 14.5 por ciento más alta de la que hubiera sido en ausencia de las nuevas variedades (HYV's); si se excluye Brasil el porcentaje sube a 40.3 (Tabla 8). En 1972-73 la producción de arroz en Asia se estimó como 4.9 por ciento más alta debido a la presencia de las nuevas variedades (HYV's).

4. En Colombia la introducción de nuevas variedades comenzó en 1964 como resultado de un amplio programa de investigación sobre arroz en el ICA y la posterior colaboración del CIAT. De este trabajo resultaron algunas variedades colombianas, primeramente ICA-10 y

Napal; luego con la introducción de materiales del IRRI siguieron IR-8 e IR-22, y finalmente el programa ICA-CIAT desarrolló dos nuevas variedades: CICA-4 y CICA-6. En un futuro muy cercano se esperan nuevos resultados provenientes de las líneas promisorias.

5. La adopción de estas variedades ha sido amplia y rápida en el sector de riego (ver Tabla 9).

6. El impacto en los rendimientos y producción nacionales ha sido espectacular.

7. Los rendimientos estimados de la variedad tradicional Blue-Bonnet-50 y de las nuevas variedades (HYV's), son comparados en la Tabla 9b.

8. La contribución de las nuevas variedades al producto nacional se presenta en la Tabla 37. El valor bruto se estimó en US$350 millones, en dólares de 1974.

9. Los cambios en la estructura de la industria arrocera se presentan en la Tabla 37a; las nuevas variedades fueron desarrolladas para condiciones de riego, dándole al sector riego una ventaja comparativa sobre el sector secano, donde no ha ocurrido ningún cambio tecnológico.

10. Los precios de arroz disminuyeron como resultado de la nueva tecnología (ver Tabla 49).

11. Se desarrolló un modelo econométrico para la producción y demanda de arroz. El sistema de ecuaciones utilizado se presenta en la Tabla 49 ; la Figura 6 repre-

senta el modelo gráficamente.

12. En base a este modelo se estimaron los beneficios brutos (ver Tabla 41).

13. Se estimaron los costos de investigación y se distribuyeron entre los dos grupos productores y consumidores (ver Tabla 41).

14. Los beneficios netos de cada grupo se resumen en la Tabla 41. Los "beneficios" al productor son negativos tanto para el sector riego como para el sector secano esto significa que los retornos a tierra y capacidad empresarial hubieran sido más altos en la ausencia de las nuevas variedades (HYV's), puesto que los precios hubieran sido mucho más altos.

15. La Tasa Interna de Retorno del programa de investigación fué igual al 94 por ciento; y la Tasa de Beneficio-Costo 7:1.

16. El ingreso no realizado castigó más fuertemente a los pequeños productores de secano (ver Figura 11).

17. Los beneficios absolutos y relativos fueron mayores para los consumidores de bajos ingresos. Para los tres grupos de ingresos más bajos el impacto fué 12.8 por ciento ($0-6.000), 7.1 por ciento ($6.001-12.000) y 3.5 por ciento ($12.001-18.000) en términos de sus niveles de ingreso en 1970 (ver Figura 10).

18. Los beneficios totales del programa de investigación estaban fuertemente concentrados en los consumidores

de más bajos ingresos (ver Figura 10).

19. Este resultado se presenta porque toda la producción adicional fué consumida en el mercado doméstico; esto significa que los precios eran mucho más bajos de lo que podrían haber sido en la ausencia de las nuevas variedades (HYV's), debido a la relativa inelasticidad de la demanda doméstica.

20. Implicaciones para las Estrategias de Investigación en Cultivos Alimenticios: Los beneficios de un aumento en la producción de alimentos debido a un cambio tecnológico serán absorbidos por los consumidores y tenderán a favorecer los grupos de ingresos más bajos cuando la producción no entra al mercado de exportaciones.

21. Las políticas de industrialización que protejen al sector manufacturero refuerzan estas políticas de alimentos baratos en una forma interesante e indirecta. La protección tarifaria del sector industrial permite que el precio de las monedas extranjeras se mantenga más bajo de lo que pudiera ser en ausencia de tal protección. Cuando el cambio tecnológico generado por la inversión pública en la investigación agrícola aumenta la oferta de alimentos, los productores tienen menos incentivos a exportar debido a la baja tasa de cambio. Por lo tanto este aumento debe ser absorbido por los mercados domésticos cuando la elasticidad precio es baja. Entonces los precios disminuyen sustancialmente

y los consumidores se benefician.

22. Este resultado se hace presente cuando hay una situación dinámica en la agricultura. En una situación estática la protección del sector manufacturero eleva el precio de los insumos al sector agrícola, reduce el producto agrícola y aumenta el precio de los alimentos.

23. Si la política cambiaria hubiera sido más favorable a los exportadores potenciales, Colombia podría haber competido favorablemente en los mercados internacionales (ver Tabla 48).

24. Los productores de arroz podrían absorber una mayor parte de los beneficios en el futuro (y una menor los consumidores) si Colombia se convierte en un principal exportador de arroz.

THE IMPACT OF HIGH YIELDING RICE VARIETIES IN LATIN AMERICA WITH SPECIAL EMPHASIS ON COLOMBIA

*Summary and Results for Discussion**

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THE IMPACT OF HIGH YIELDING RICE VARIETIES IN LATIN AMERICA WITH SPECIAL EMPHASIS ON COLOMBIA

1. This study was undertaken at the request of the Board of Trustees of CIAT, with the objective of documenting and analyzing (i) the contribution of HYV's in Latin America; and (ii) the size and distribution of the economic benefits from the introduction of new rice varieties in Colombia.

2. In 1974, at least 800,000 has (or 12 percent) of the rice area in Latin America was sown to HYV's.

3. In 1974, Latin American output was 14.5 percent higher than it would have been in the absence of HYV's; excluding Brazil, the figure in 40.3 percent (Table 8). In 1972-1973, Asian production was estimated to be [illegible] percent higher due to HYV's.

4. In Colombia, the introduction of new varieties commenced in 1964 as a result of an expanded program of rice research in ICA and with the subsequent collaboration of CIAT. This work resulted in the release of a number of Colombian varieties (ICA-10, Napal), followed by the introduction of material from IRRI (IR-8 and IR-22) and finally with the development of two new varieties by the ICA-CIAT program (CICA-4 and CICA-6). Further releases from advanced promising lines are expected shortly.

5. The adoption of these varieties in the irrigated sector

has been rapid and widespr ad (see Table 9).

6. The impact on national yields and production has been spectacular (see Table 9a).
7. The estimated yields of the traditional variety, Blue-Bonnet-50, and the HYV's are compared in Table 9b.
8. The contribution of the new varieties to national production is shown in Table 37. The gross value was estimated at $(US)350m, in 1974 dollars.
9. The changing structure of the rice industry is shown in Table 37a; the new varieties were developed for irrigated culture, giving the irrigated sector a comparative advantage over the upland sector where no technological change occurred.
10. Rice prices fell as a result of the new technology (See Table 49).
11. An econometric model of rice production and demand was developed. The system of equations used is shown in Table 49a, and Figure 6 presents the model graphically
12. On the basis of this model the gross benefits were estimated. (See Table 41).
13. The research costs were estimated and distributed by groups of producers and consumers (See Table 41).
14. The net benefits to each group are summarized in Table 41. Producer "benefits" are negative, both for upland and irrigated sectors - this means that the return to land and entrepenuerial skills would have been higher in the

absence of HYV's, as the prices would have been much higher.

15. The Internal Rate of Return to the research program was 94%; the benefit: cost ratio, 77:1

16. The foregone income was borne heavily by small upland producers (see Figure 11).

17. The absolute and relative benefits to were greatest for low income consumers. For the three lowest income groups the impact was 12.8% ($0-6,000), 7,1% ($6,001 - $12,000) and 3.5% ($12,001 - $18,000) of their 1970 income levels (see Figure 9).

18. The overall benefits of the research program were highly skewed toward the lowest income consumers (see Figure 10).

19. This result came about because the additional production was all disposed of on the domestic market, meaning that prices were much lower than they would have been in the absence of the HYV's, due to the relatively inelastic domestic demand.

20. Implications for Research Strategy on Food Crops: The benefits of expanded output on food crops brought about by technological change will be captured by consumers, and will tend to favor lower income groups when the crop does not enter export markets.

21. Industrialization policies which protect the manufacturing sector contribute to this cheaper food policy in an

interesting and indirect way. Tariff protection to the industrial sector allows the price of foreign exchange to be maintained lower than it would be in the absence of such protection. When technological change generated by public investment in agricultural research shifts the supply of food crops, producers have less incentive to export because of the lower exchange rate. Hence the expanded output has to be absorbed by the domestic market where the demand elasticity is low. Thus prices fall substantially and consumers benefit.

22. This result comes about when there is a dynamic situation in agriculture. In a static situation, protection of the manufacturing sector raises input prices to the farm sector, reduces farm output, and raises food prices.

23. Had the exchange rate policy been more favorable toward potential exporters, Colombia could have competed favorably in export markets (see Table 48).

24. Rice-producers will capture more of the benefits in future (and consumers less) if Colombia becomes a significant exporter of rice.

TABLE 8

Estimated Contribution of HYV's in Latin America Excluding Brazil:

By Regions: 1974

Item	Units	Mexico and Caribbean	Central America	South America	Colombia (Irrigated)	Latin America (Excl. Brazil)
(1) Total Area	'000 has	452.0	257.1	1,088.0	273.0	1,797.0
(2) Total Production	'000 m.t	1,022.0	472.2	3,647.1	1,420.1	5,141.4
(3) Yield	t/ha	2.261	1.837	3.352	5.203	2.861
(4) HYV Area	'000 has	264.0	105.3	438.5	270.2	807.8
(5) Traditional Area	'000 has	188.0	151.8	649.5	2.7	989.2
(6) Traditional Yield	t/ha	1.779	1.284	2.399	3.100	2.040
(7) Traditional Prod.	'000 m.t	334.5	194.9	1,558.2	8.4	2,018.0
(8) HYV Production	'000 m.t	687.5	277.3	2,088.9	1,411.7	2,123.4
(9) HYV Yield	t/ha	2.604	2.633	4.764	5.225	3.867
(10) Yield Margin	t/ha	0.825	1.349	2.365	2.125	1.827
(11) Additional Prod.	'000 m.t	217.8	142.0	1,037.1	574.2	1,475.9
(12) Additional Prod.	%	27.1	43.0	39.7	67.9	40.3

Derivations:

(5) = (1) - (4)

(6) = Average yield 1950-1964

(7) = (5) . (6)

(8) = (2) - (7)

(10) = (9) - (6)

(11) = (10) . (4)

(12) = ((11)/((2) - (11)))* 100

TABLE 9

Percentage Distribution of Varieties in Colombia: 1964 - 1974

Year	Blue-Bonnet-50	Napal	Tapuripa	ICA-10	Dwarfs IR-8	Dwarfs IR-22	Dwarfs CICA-4	Others
	%	%	%	%	%	%	%	%
1964	87	5	-	-	-	-	-	8
1965	87	5	-	-	-	-	-	8
1966	90	-	-	-	-	-	-	10
1967	80	-	7	-	-	-	-	13
1968	53	-	42	-	-	-	-	5
1969	50	-	36	1	5	-	-	8
1970	36	-	26	-	29	-	-	9
1971	35	-	14	-	37	3	4	7
1972	12	-	-	-	27	30	30	1
1973	2	-	-	-	41	39	18	0
1974	1	-	-	-	31	33	27	8

Source: FEDEARROZ (1973 and 1975).

TABLE 9a

Area Yield and Production of Rice in Colombia:
Selected Years

Year	Area	Yield	Production
	'000 has	t/ha	'000 m. ton
1954	175	1.7	294
1960	227	2.0	450
1965	375	1.8	672
1968	277	2.8	786
1972	273	3.8	1,043
1975	369	4.4	1,632

TABLE 9b

Estimated Yields of Traditional and Modern Varieties
Colombia: 1964-1974

Year	Bluebonnet-50	HYV's
	t/ha	t/ha
1964	3.1	3.2
1965	3.0	3.8
1966	3.0	-
1967	3.3	5.8
1968	3.2	5.6
1969	3.0	5.5
1970	3.3	6.1
1971	3.4	6.3
1972	3.0	5.5
1973	2.9	5.3
1974	2.8	5.2

TABLE 37

Estimates of the Quantity and Gross Value of Additional Rice Production in Colombia due to HYV's: 1964-1974

Year	Actual Production[a]	Estimated Production without HYV's at Actual Prices[b]	Estimated Production without HYV's at Equilibrium	Additional Production[d]	Price received by Latin American Exporters	Value of Additional Production
	m.t.				$(US)/m.t	$(US)m.
1964	600,000	599,019	599,353	421	142	0.06
1965	672,000	666,596	668,433	2,319	110	0.26
1966	680,000	680,000	680,000	0	149	0.00
1967	661,500	642,196	648,759	8,282	142	1.18
1968	786,300	588,623	655,833	84,804	138	11.70
1969	694,500	553,097	601,174	60,662	123	7.46
1970	752,595	533,167	607,773	94,134	94	8,85
1971	904,348	582,236	691,754	138,186	107	14,79
1972	1,043,284	513,888	693,383	227,111	164	37,25
1973	1,175,871	503,263	731,950	288,549	212	61.17
1974	1,569,940	523,563	879,331	448,896	333	149.48

[a] Corresponds to OA in Figure 6 or Q_1 in Figure 8, and is from Table 11.

[b] Corresponds to OE in Figure 6 or Q_2 in Figure 8.

[c] Corresponds to Q_0 in Figure 8, and given by equation (6.1).

[d] Corresponds to $Q_1 - Q_0$ in Figure 8, and converted to milled rice equivalent.

TABLE 17a

Yields and Production of the Upland and Irrigated Sectors: Colombia: Selected years

Year	Upland		Irrigated	
	Yield	Production	Yield	Production
	t/ha	'000 m.t.	t/ha	'000 m.t.
1954	1.1	124	2.7	171
1960	1.2	187	3.9	263
1965	1.1	276	3.0	396
1968	1.7	251	4.2	536
1972	1.6	161	5.2	883
1975	1.6	152	5.4	1,480

TABLL 49

Real Rice Prices[a] and Marketing Margins for Selected Periods: Colombia: 1950-1974

Average of	Farm (P_f)	Whole Sale	Retail (P_r)	Farm-to-whole sale	Whole-Sale-to-retail	Farm-to-Retail	Retail/Farm Price (P_r/P_f)
1950-52	1,258	2,888	3,266	1,630	378	2,008	2.60
1957-59	1,394	2,901	3,432	1,507	531	2,038	2.46
1965-67	1,506	3,096	3,559	1,590	463	2,053	2.36
1972-74	1,007	2,542	2,972	1,535	430	1,965	2.95

[a] Expressed in 1964 pesos.

TABLE 9a

An Econometric Model of Rice Supply and Demand

Demand: $P_t = \alpha Q_{T,t}^{1/\eta}$

Supply (Irrigated): $Q_{I,t} = \beta P_{t-1}^{\varepsilon_I}$

Supply (Upland): $Q_{\mu,t} = \gamma P_{t-1}^{\varepsilon_\mu}$

Supply (Total): $Q_{T,t} = \delta P_{t-1}^{\varepsilon}$

Supply (Irrigated) without HYV's: $Q_{I,t} = (1-k_{I,t})\beta P_{t-1}^{\varepsilon_I}$

Supply (Total) without HYV's: $Q_{T,t} = (1-k_{T,t})\delta P_{t-1}^{\varepsilon}$

Identity: $Q_{\mu,t} + Q_{I,t} = Q_{T,t}$

Identity: $\varepsilon = P_I\varepsilon_I + (1-P_I)\varepsilon_\mu$

where

P_t = deflated price of rice;

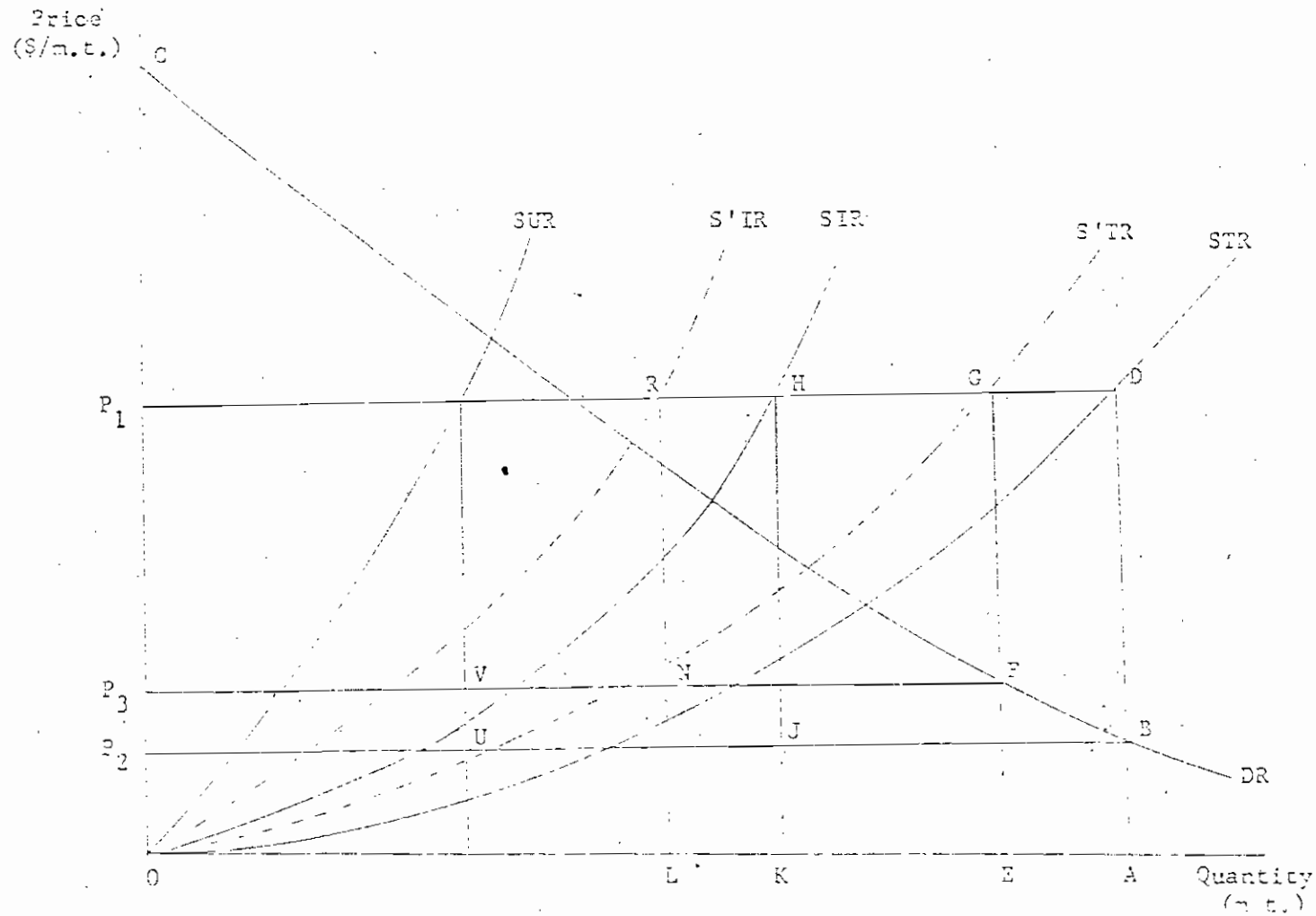
Q_t = quantity of rice;

η = elasticity of demand;

$\varepsilon_\mu, \varepsilon_I, \varepsilon$ = elasticities of supply;

k_I, k_T = shift parameters;

P_I = proportion of production from irrigated sector.



Graphical representation of the model for estimating the Distribution of Gross Benefits from the Introduction of HYV's of Rice

TABLE 41

Size and Distribution of Benefits and Costs[a] of HYV's in Colombia: 1957-1974

Item	Producers			Consumers	Total Colombia	International Cooperation
	Upland	Irrigated	Total			
	$m	$m	$m	$m	$m	$m
Gross Benefits	-3,542.1	-5,292.9	-8,835.0	14,939.3	6,104.3	-
Costs of Research FEDEARROZ	8.4	29.9	38.3	-	38.3	-
Costs of Research ICA	0.7	1.7	2.4	22.1	24.5	-
Costs of Research Total	9.1	31.6	40.7	22.1	62.8	18.8
Net Benefits	-3,551.2	-5,324.5	-8,875.7	14,917.2	6,041.5	-

[a] All data expressed in $m. 1970.

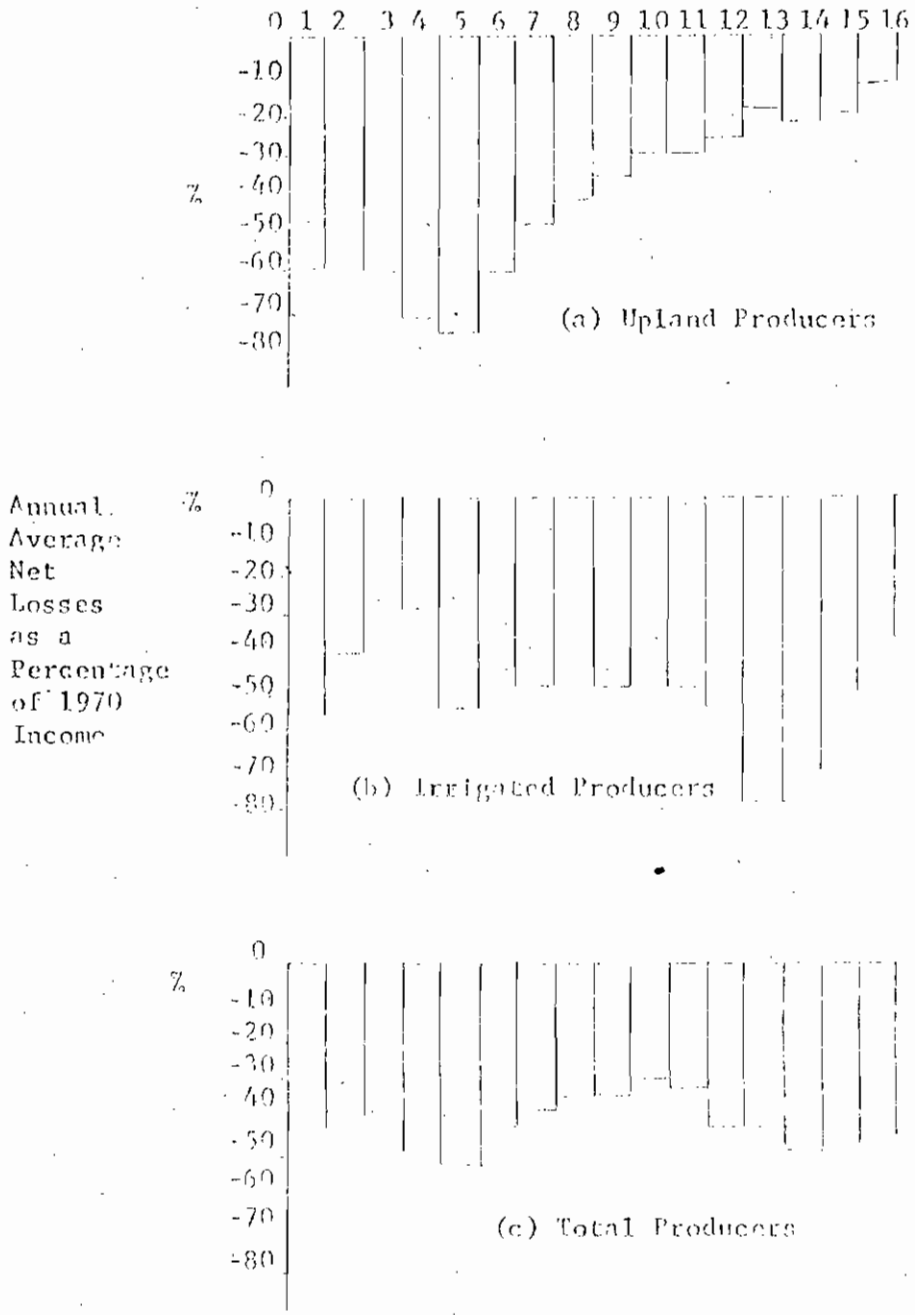


FIGURE 11: Distribution of Annual Average Net Losses to Producers: By Level of Income

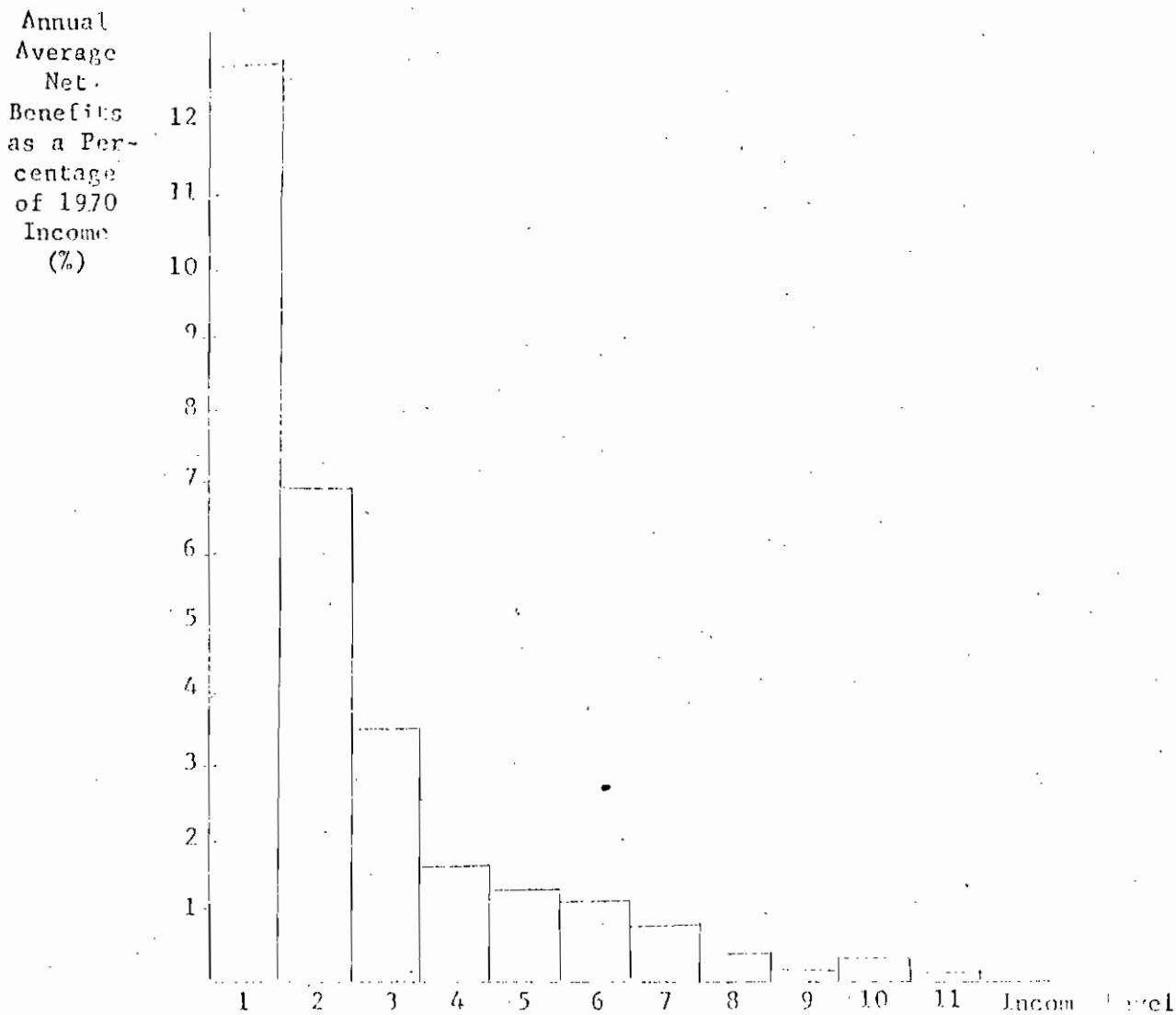


FIGURE 9: Distribution of Annual Average Net Benefits to Consumers: By Level of Income

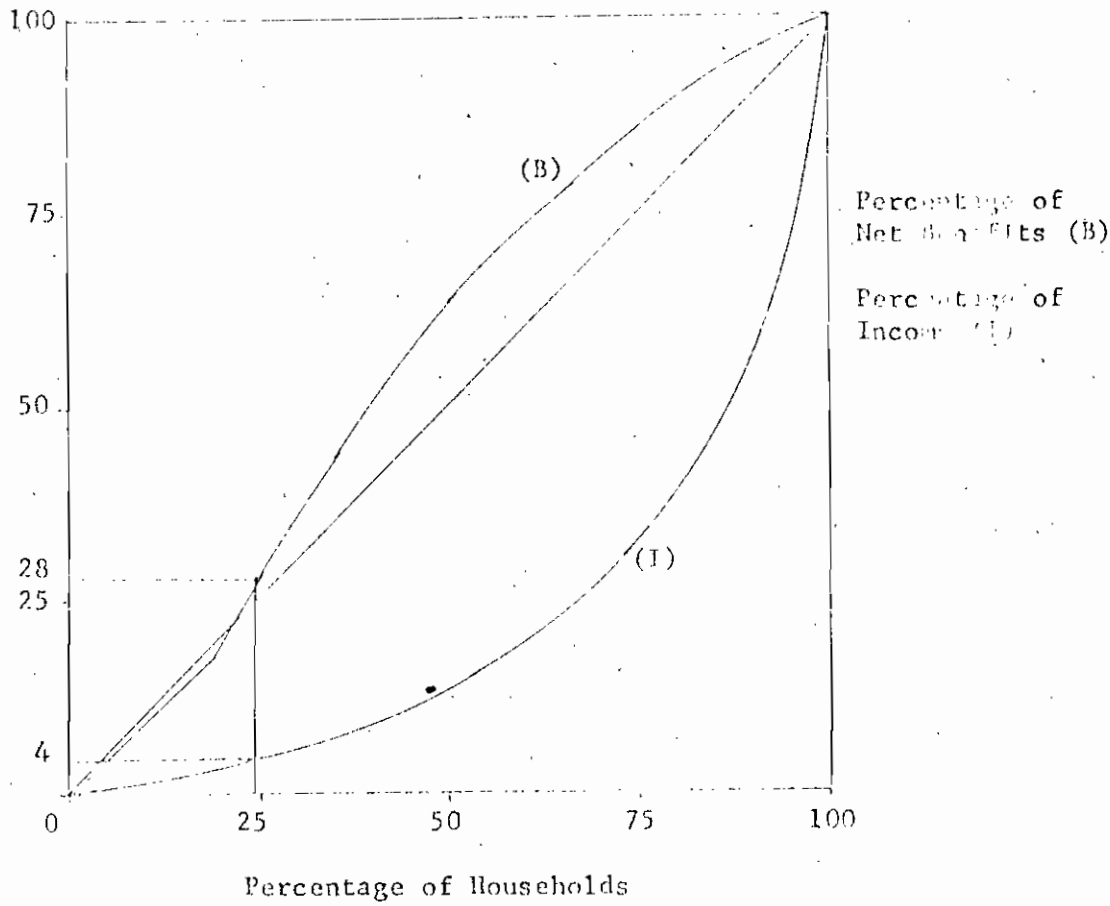


FIGURE 10: Distribution of Income and Net Consumer Benefits from HYV's in Colombia

TABLE 48

Competitive Position of Colombia as a Rice Exporter: 1958-1974

Year	Price in Colombia[a] (fob) (1)	Shadow Exchange Rate[b] (2)	Price in Colombia (fob) (3)	Export Price of Competitors[c] (fob) (4)	Competitive Margin of Colombia[d] (5)	Milled Rice Exports From Colombia
	$Col	$Col/$US	$US	$US	%	'000 m.t
1968	3,440	25.43	135	138	+2	0
1969	3,153	26.90	117	123	+5	24
1970	3,146	28.76	109	94	-16	5
1971	3,320	31.50	105	107	+2	0
1972	3,298	34.32	96	164	+41	3
1973	4,470	37.34	120	212	+43	20
1974	6,121	43.04	142	333	+57	1

a Based on price paid to farmers, plus milling, and transport to port.

b Actual rate inflated by 50 percent to reflect overvaluation.

c Weighted average export prices received by six consistent exporters from Latin American (Nicaragua, Guyana, Surinam, Argentina, Brazil and Uruguay).

d ((4)-(3))/(4)*100