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POTENTIAL IMPACT OF THE USE OF PASTURES ASSOCIATED WITH CROPS IN THE TROPICAL SAVANNAS OF LATIN AMERICA

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INTRODUCTION

The tropical savannas of Latin America constitute a very abundant resource Thus, their efficient utilization from an economic and rational standpoint in terms of conserving natural resources could contribute to substantially increasing the regional food supply, both from crops and livestock There is ample literature on the climatic, edaphic, and socioeconomic characteristics of savanna ecosystems and the nature of the technological limitations on their efficient utilization (Cochrane and Sanchez, 1980, Vera and Sere, 1985)

It is estimated that in the Latin American tropics there are some 880 million ha with acid, infertile soils (Sanchez and Tergas, 1979), of which some 380 million ha of savannas and Cerrados are currently used for agricultural and livestock activities (Sere and Jarvis, 1988)

The predominant production systems in these regions are characterized by being extensive, with low production per head of cattle and per hectare (CIAT, 1987) Low productivity is closely linked with the lack of suitable technologies for pastures and crops that make it possible to intensify soil use

The agricultural frontier regions such as the savannas have unfavorable price relations (low prices for products and high costs of inputs), which implies that if the economic viability of using new technologies is to be increased, then an appropriate strategy would be to develop technologies that require a minimum use of purchased inputs Research efforts by CIAT and collaborating entities that employ this approach have led to the release of new varieties of grasses and legumes adapted to savanna conditions *Andropogon gayanus*, *Stylosanthes capitata*, *Brachiaria dictyoneura*, and *Centrosema acutifolium*, among others

The main limitation on a faster rate of diffusion of the new grasses is their high cost of establishment A survey of 86 producers from the Colombian highland plains conducted in 1989 showed that 41% of those interviewed indicated high establishment costs as the

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main limitation on adopting improved pastures (Cadavid et al, 1990) In addition, seed availability constitutes an important constraint at present for the adoption of legumes

Given the above, there is a need to find viable alternatives that make it possible to lower establishment costs There are several options for this, one of which would be to lower seed costs, which represent a high proportion of total establishment costs The cost of this input within the theoretical "basket" of minimum inputs at the different locations of the RIEPT (Red Internacional de Evaluacion de Pastos Tropicales) fluctuated in 1986 from 20% to 47% of the cost of the basket (Rivas and Sere, 1987) To lower production costs and market prices for seed requires both intermediate- and long-term research, as it is necessary to increase the yields of seed harvested per hectare

Another possibility for lowering costs is to plant pastures in association with crops so that some of the establishment costs are shared between the pastures and the crop This is a strategy that has been used with success in some Latin American regions where the establishment of large extensions of pastures has been associated with a profitable crop such as rice in the Brazilian Cerrados or wheat in the Argentine Pampas (Sere and Estrada, 1987) These crops have not necessarily been planted in association with pastures, but the crop is used as the pioneer for the later introduction of pastures, which frequently occurs when expanding the agricultural frontier

Research on crops for acid soils is progressing rapidly, and rice lines that are tolerant to high degrees of acidity are already available (CIAT, 1989 and 1990) The Instituto Colombiano Agropecuario (ICA) has recently released two new sorghum varieties for acid soils 'Sorgica Real 30' and 'Sorgica Real 60' In the Brazilian Cerrados, there are soybean varieties adapted to the conditions of that ecosystem It is thus possible to foresee that in the near future crop-pasture associations will play an important role in the process of utilizing and intensifying production on savanna areas

Preliminary **ex ante** evaluations of the associated planting of rice and pastures for the Colombian highland plains (Altillanura) indicate that this option is highly profitable and that the costs of establishing the rice-pasture association are recovered in the first year with income generated from selling the rice (Botero et al, 1991, CIAT, 1989, Valencia, 1990)

Besides analyzing the attractiveness and viability of this alternative at the level of the individual producer, it is important to try to quantify the overall impact of adopting a technology of this nature in terms of additional production generated, value of the additional production, value of the economic surpluses (social), and evolution of markets in terms of prices and quantities

The purpose of this study is to evaluate this impact, simulating the process of technology adoption on an area of 10 million ha presently in savannas, assuming that 5 million ha are for fattening cattle and the other 5 million are for dual-purpose activities (meat and milk)

AREA UNDER NEW TECHNOLOGY

After defining the total area (10 million ha) to receive an impact from the new technology, a logistical function is used to simulate the area that is cultivated yearly in rice-pasture associations and to estimate levels of production The logistical function corresponds to the functional form

$$Y_t = \frac{K}{1 + e^{\alpha + \beta t}}$$

where

Y_t = area planted in year t
K = total area to be planted during the diffusion process
α, β = constants
t = time

In this case, two logistical functions are adjusted one for the areas destined for fattening (5 million ha) and the other for the dual-purpose activities (milk and beef) (5 million ha) For these activities, different diffusion times are assumed 20 years for dual-purpose and 35 years for fattening activities It is also assumed that, in the first year of adoption, 0 5% of the target area will adopt the new technology and that, in the final year of adoption, 99 9% of the target area will be planted to rice-pasture associations The development of the planted areas is shown in Figure 1

Once the areas planted yearly are defined, the additional value of rice, meat, and milk production is calculated using the technical coefficients shown in Table 1

The time frame for calculating benefits with a common time base for both the dual-purpose and fattening systems is 35 years The calculated production is incremental, that is, the difference between the volume of production that would be obtained with the improved technology in relation to that on native savanna

Therefore, beef production in period t is defined as

<u>Period</u>

1 $PB_1 = -A_1Y_1$

2 $PB_2 = A_1Y_2 - A_2Y_1$

3 $PB_3 = A_1Y_3 + A_2Y_2 - A_3Y_1$

4 $PB_4 = A_1Y_4 + A_2Y_3 + A_3Y_2 - A_4Y_1$

5 $PB_5 = A_1Y_5 + A_2Y_4 + A_3Y_3 + A_4Y_2 - A_5Y_1$

6 $PB_6 = A_1Y_6 + A_2Y_5 + A_3Y_4 + A_4Y_3 + A_5Y_2 - A_6Y_1$

7 $PB_7 = A_2Y_6 + A_3Y_5 + A_4Y_4 + A_5Y_3 + A_6Y_2 - A_6Y_1 - A_1Y_1$

8 $PB_8 = A_3Y_7$

35 $PB_{35} =$

where

PB_i = production of beef on the hoof in period i
A_i = area planted in period i
Y_i = additional production of beef on the hoof/ha in period i

It should be noted that, in the first period, production is negative because it was assumed that the period of establishment takes one year The negative sign for production indicates what would have been produced on the native savanna if the new technology had not been adopted

Given that pasture persistence was assumed to be six years, in the seventh year the area planted for the first time in the first period is replanted, and so on, until year 35

Rice production is calculated as

<u>Period</u>

1 $PR_1 = A_1B_1$

2 $PR_2 = A_2B_1$

3 $PR_3 = A_3B_1$

4 $PR_4 = A_4B_1$

5 $PR_5 = A_5B_1$

6 $PR_6 = A_6B_1$

7 $PR_7 = A_1B_2 + A_7B_1$

35 $PR_{35} =$

where

PR_i = rice production in period i
B_1 = rice production per ha at the first planting
B_2 = rice production per ha at the second planting

This manner of calculating production was used for the two production systems (fattening and dual-purpose), however, for the latter, milk production was also estimated. The yearly flow of milk production was estimated as

<u>Period</u>

1 $PM_1 = A_1M_s$

2 $PM_2 = A_1M_p + A_2M_s$

3 $PM_3 = A_1M_p + A_2M_p + A_3M_s$

4 $PM_4 =$

5 $PM_5 =$

6 $PM_6 =$

7 $PM_7 = A_1M_s + A_2M_p + \quad A_7M_s$

35 $PM_{35} =$

where

PM_i = milk production in period i
M_s = milk production per ha on native savanna = 0
M_p = milk production per ha on improved pastures

Once the flow of production for the 35-year period has been calculated, its current value is calculated on the basis of the prices that appear in Table 1, with a yearly discount rate of 10%

ADDITIONAL PRODUCTION

The additional yearly production of live weight, derived from the adoption of associations of pastures and rice on a total area of 10 million ha, is 740 thousand tons in year 35 (Table 2) The additional production in the last year of adoption is equivalent to 6 7% of the production of tropical Latin America in 1988 Since it is assumed that those 10 million ha are located in three countries (Brazil, Colombia, and Venezuela)[4], the additional production represents 11% of the combined production of these countries

The additional yearly production of milk, as a result of the utilization of 5 million ha for dual-purpose cattle-raising activities, amounts to 3 7 million liters by year 35 (Table 2), equivalent to 12% of the milk production of tropical Latin America in 1988 and 21% of the total production of the aforementioned countries

The impact on rice production is of greater magnitude--with additional yearly production reaching 4 7 million tons in year 35 In terms of percentages, this represents 24% of the production of tropical Latin America in 1988 and 33% of the combined production of Brazil, Colombia, and Venezuela in that same year

BENEFITS OF THE NEW TECHNOLOGY

To estimate the impact of the new technology, two methodological approaches were used

1 The present value of the additional production, which gives an idea of the gross income associated with the new technology, without incorporating possible changes in market prices induced by the technological change itself

2 The economic surpluses that incorporate the effect of the technological change in a model of partial equilibrium

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[4] *These countries have 86% of the acid soils in Latin America and 88% of the cattle stock on those soils (Seré, 1984)*

Present Value of the Additional Production

Table 3 shows the present value of the additional production of beef, rice, and milk generated in two cattle production systems (fattening and dual-purpose) employing pastures planted in association with rice

The current total net value, discounted at an annual rate of 10%, is US$6 035 billion for a period of 35 years Of this value, 46 7% corresponds to rice and 53 3% to milk and beef Given that there is an interaction between the productivities of rice and pastures when planted in association, an approximate estimate was made of the contribution of each component of the association to the productivity of the other Under these assumptions,

it was estimated that the present value of the contribution of pastures to the greater productivity of rice was US$634 million

This benefit is derived from the fact that upon replanting the area that was initially in rice-pastures, the improved soil fertility for the new rice-pastures association makes it possible for the first crop to yield 1000 kg/ha higher than in the initial planting (an increase of 55%) The same reasoning applies to the case of pastures, where it is assumed that they will have greater productivity (expressed in kg of beef/ha) because of improved soil fertility The present value of the greater productivity of pastures due to the presence of rice was estimated at US$54 million

The present value of the additional production is a rough indicator of the benefits that producers receive as a result of adopting a given technology In this case, production levels are estimated based on the assumption that prices remain constant over the period of diffusion, at the same level of prices for the initial year Nevertheless, if the price to

the producer falls as a result of a greater supply, with demand remaining constant, production levels and their present value would be lower

The present value represents gross income, because it includes production costs In spite of this limitation, this value is an indicator of the level of activity that can be generated in other sectors of the economy, related to the productive sector where there is technological change In economic terminology, these are the so-called "forward and backward linkages"

The present value of the additional production is then used to calculate the multiplier effect of these linkages, which measure the net change of products and services that are generated outside the sector being analyzed as a result of the technological change in question (Janssen et al, 1990b)

A more elaborate methodological alternative for measuring the impact of technological change is to calculate the economic surpluses for producers and consumers in order to determine the net social benefits that different groups receive when a technological innovation is spread

Economic Surpluses

The economic surpluses approach makes it possible to analyze technological change within the broader context that examines (1) the market for the product being analyzed, in terms of total quantities, prices, and benefits to producers and consumers, and (2) the economic surpluses derived from other market forces (autonomous changes)

To calculate the economic surpluses, the "Model of Analysis of Economic Surpluses" (MODEXC), developed at CIAT (Rivas et al, 1991), was used This model starts from a situation of supply and demand equilibrium and then simulates the evolution of the market over time, considering independently the displacement of supply resulting from technological changes and autonomous factors, as well as the displacement of demand resulting from growth of income, population, etc

In order to calculate these economic surpluses, it was assumed that the 10 million ha under new technology were located in Brazil, Colombia, and Venezuela, therefore, this is a simulation of the evolution of the beef, rice, and milk markets in the three countries taken together The assumptions used to calculate the economic surpluses are presented in Table 4

The present value of the total economic surplus, discounted at 10% yearly, that can be attributed exclusively to the technological change analyzed, is equivalent to US$1 5 billion with 42 8% corresponding to rice, 37 2% to milk, and 20 0% to beef (Table 5)

Given the nature of staples such as rice, beef, and milk, which are characterized by having relatively low demand price elasticities, the benefits arising from the technological change are concentrated on consumers as a result of reduced prices and increased consumption In the case analyzed here, the technological change reduced the real prices of rice by 19 4%, those of milk by 9 0%, and those of beef by 7 0% Figure 2 shows the evolution of these prices

The producer, who benefits from the technological change in the form of increased productivity (reduction of marginal costs), is affected by a reduction in prices received The net balance between the value of increased productivity and reduced prices determines whether the producer obtains a positive or negative benefit when adopting the new technology The more inelastic the demand of the product analyzed, the greater will be the reduction in price and the possibility that the surplus received by the producer as a result of the technological change will be negative

In this case, the sum of the surpluses due exclusively to the technological change received by consumers of rice, beef, and milk is US$2 9 billion, but for the producer, it is only US$-1 3 billion (Table 5)

The question arises If producers lose money when they adopt new technologies, then why do they do so? In order to understand this, it is necessary to analyze several aspects The first is that in the evolution of markets, forces of a diverse nature intervene simultaneously, displacing the functions of supply and demand, on the supply side, one of them can be the technological change resulting from the application of a specific technology developed by a research entity, as was the case of the associated planting of rice-pastures

There can be other changes in the production systems, independent of the technological change analyzed here, that also displace the supply functions, e g , increases in the level and quality of resources used or changes in management of cattle and crops, so that at a given price the quantity offered on the market will increase In fact, there can be changes that are not independent of the technological change analyzed that can increase its impact for example, the use of improved pastures associated with improvements in management and quality of cattle used In the case of crops, improved varieties can be used together with improved methods for preparing the soil and the use of inputs In other words, the use of a new technology can induce changes in other components of the system (Janssen et al , 1990a) On the demand side, increases in income and population and changes in relative prices generate displacements of this function

In the present case, it was assumed that, in addition to the growth of supply and demand that would have been produced without technological change, the market is influenced by an additional supply movement, resulting from the adoption of the new rice-pasture technology It was assumed that due to autonomous factors, supply and demand in the three markets would grow at an annual rate of 1 5% The result is that even if the technological change reduced real prices, thus benefiting the consumer, producers would also obtain a positive total surplus (the sum of the autonomous surpluses and those resulting from the technological change) Under these assumptions, the total net surplus received by producers would come to US$5 175 billion (Table 5) These endogenous and exogenous changes simulate a situation of general equilibrium, although they are really a "corrected" partial equilibrium

SENSITIVITY OF ECONOMIC SURPLUSES

Economic surpluses are very sensitive to the assumptions made for calculating them the type of supply and demand functions that are adopted (lines, curves), the nature of the displacement of the functions (parallel, pivotal, divergent, convergent), the assumed values of elasticities, the supply and demand displacement factors, the discount rate used, and the length of the period for diffusing the new technology These last two have an appreciable effect on the value of benefits expected from the technological change

The period required for technology diffusion is particularly difficult to predict It depends, among other factors, on the relative attractiveness of the new technology (measured by its profitability at the producer level), the availability of the physical and financial resources required to adopt the new techniques, the availability of crucial inputs (credit, seeds, etc), the appropriateness of the technology, and market and biological risks associated with using the technological innovation (Aluja et al , 1988)

In the case of milk, for example, an efficient infrastructure is required for collecting, processing and distributing production--both for accelerating adoption and extending the area of impact[5] This means that there are factors independent of the inherent nature of the technological change that condition its level of adoption

Given the foregoing, a sensitivity analysis of the net benefits derived from the technological change was run, with respect to two variables the social discount rate and the length of the diffusion period

The value of the net economic surpluses varied between US$13 7 billion if the discount rate used was 1%, and US$0 3 billion if it was 20% (Table 6) The social discount rate can be interpreted as a measure of the value that society places in the present on future benefits If the discount rate is high, this means that society is not interested in long-term projects because little value is placed on benefits that are not immediate In other words, society places greater value on current consumption

The temporary value placed on social benefits is a function of current consumption, that is, if a society already has high levels of consumption, it is more interested in conserving natural resources and generating long-term benefits, which is reflected in a low social discount rate On the other hand, a society with low levels of consumption places a high value on real increases in this area, placing a low priority on the conservation of resources and long-term benefits, which is expressed in a high social discount rate (Hoekstra, 1983)

The length of the diffusion period is also a critical variable for estimating the social benefits of research To the extent that adoption is more rapid, the present value of the social benefits increases Using a social discount rate of 10%, the present value of the social benefits resulting from the technological change fluctuates between US$4 2 billion, if the diffusion period is 10 years, and US$1 5 billion if it is 35 years (Table 7) It should be noted that an increase of 25 years in the diffusion period would decrease the present value of the benefits by US$2 7 billion, which, when expressed on a yearly basis, would be equivalent to US$297 7 million per year (Table 7)

The foregoing shows the importance of diffusion, extension, and training programs, as well

[5] *An analysis of the external factors that determine adoption of new technology in dairy farming can be found in Michelsen (1990)*

as the creation of the social infrastructure and supply of critical inputs (seeds, credit, etc), that permit a society to obtain the benefits derived from new technologies rapidly

SUMMARY AND CONCLUSIONS

This study attempts to quantify the **ex ante** impact of using the new technology of planting rice-pasture associations, simulating their adoption on an area of 10 million ha presently in savannas

The impact is measured using two methodological approaches in terms of

1 Additional production of rice, beef, and milk generated by using 5 million ha for fattening cattle and 5 million ha for dual-purpose operations

2 Evolution of the markets for rice, beef, and milk, in terms of quantities and prices, when the new technology is incorporated

3 The present value of the economic surpluses derived from the technological change and autonomous changes that affect the markets

4 Sensitivity analysis of those surpluses in relation to two critical variables social discount rate and duration of the diffusion period

The first method quantified the value of the additional production at real prices, constant at the level of the initial year of adoption (These would be the maximum production levels that could be obtained) To the extent that prices are lowered by the additional production resulting from the technological change, the present value of the additional production would be lowered by two factors lower price and lower production in relation to the maximum that could be obtained at constant prices

Because there is an interaction between pastures and rice that affects the productivity of both, an attempt was made to measure the contribution of each component of the association to the productivity of the other The present value of the contribution of rice to the greater productivity of pastures was estimated at US$54 million--approximately 2% of the present value of the combined production of milk and beef The contribution of pastures to the greater productivity of rice was valued at US$634 million, equivalent to 22% of the present value of rice production

This first approach was the simplest method for estimating the impact of the technological change, but it did not permit an analysis of market evolution, nor a distribution of the benefits of the technology between consumers and producers

Given the limitation of that methodological approach, the social economic surpluses derived from the technological change were estimated, within a broader framework that made it possible to analyze the technological change in the context of a market for each product For this purpose, the model developed at CIAT for calculating economic surpluses (MODEXC) was used

Results indicate that a technological change such as the one analyzed would essentially benefit consumers of the three staples The present value, discounted at 10% yearly, of the benefits captured by consumers is estimated at US$2 9 billion--20 1% corresponding to beef, 29 5% to milk, and 50 4% to rice

Producers who adopt the new technology have positive net surpluses (US$5 1 billion) despite the fact that those specifically linked to the technological change analyzed are negative (US$ -1 3 billion)

In conclusion, it can be said that a technological change such as the one analyzed here presents a high level of potential benefits even when those benefits are estimated using high social discount rates and long periods for diffusing the new technology Nevertheless, the surpluses are appreciably reduced when the duration of the diffusion period is extended, indicating that funds allocated to diffusion, extension, and creation of infrastructure have a high social return

The main shortcoming of the study is that it is based on a partial equilibrium model that ignores important linkages and crossed effects with other economic activities within and

outside the agricultural sector Adoption of this technology is at a very incipient stage and, consequently, there are few empirical data to support any adoption pattern for the future

However, it is believed that the assumptions underlying the exercise are somewhat conservative

This **ex ante** analysis serves only the purpose of indicating the potential economic impact of new technological alternatives being analyzed, providing clear guidelines to prioritize research on them A better understanding of the diffusion process and of the constraints on adoption requires careful **ex post** monitoring of the various farming systems to arrive at a more precise indication of the impact and potential of the new technologies

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Table 1. Technical and economic coefficients used to calculate the additional production resulting from the associated planting of rice-pastures in savanna areas

Item	Fattening activities	Dual-purpose activities
Total area (millions of ha)	5	5
Beef production on native savanna (kg/ha/yr)	15	15
Beef production on improved pastures, grass-legume-rice association (kg/ha/yr)		
First year	0	0
Second year	180	70
Third year	160	65
Fourth year	150	60
Fifth year	145	55
Sixth year	140	50
Milk production (liters/ha/yr)	-	900
Rice production (kg/ha/yr)		
At first planting	1800	1800
At second planting	2800	2800
Contribution of rice to the greater productivity of pastures (kg of beef/ha/yr)		
First year	25	10
Second year	5	5
Contribution of pastures to the greater productivity of rice (kg of rice/ha/yr) after the first planting (year 7)	1000	1000
Prices to the producer		
Beef on the hoof (US$/t)	500	
Paddy rice (US$/t)	200	
Fresh milk (US$/t)	200	
Yearly discount rate (%)	10	

Table 2 Evolution of the additional production of rice, beef, and milk resulting from the associated planting of rice-pastures on tropical savannas

Period in years	Rice ('000 t)	Beef ('000 t)	Milk ('000 liters)
5	277	24	186
10	1514	118	1398
15	2764	317	3323
20	3716	523	3730
25	4490	659	3730
30	4537	724	3750
35	4662	740	3735

Table 3 Present value of the additional production resulting from the planting of 10 million ha in rice pasture associations on savannas of tropical Latin America [a]

Cattle raising activities	Area planted to rice pasture associations ('000 ha)	Period of		Present value of the additional production (US$ million)			Present value of the contribution (US$ million)		Present value of the additional net production (US$ million)		
		Diffusion (years)	Evaluation (years)	Beef	Milk	Rice	Of rice to the greater productivity of pastures	Of pastures to the greater productivity or rice	Beef + Milk	Rice	Total
Fattening	5,000	35	35	522 9		963 7	27 7	210 6	705 8	780 8	1,486 6
Dual purpose	5,000	20	35	309 1	2,384 5	1,855 3	26 0	423 7	3 091 3	1,457 6	4 548 9
Total	10,000		35	832 0	2,384 5	2,819 0	53 7	634 3	3 797 1	2,238 4	6,035 5

a At constant prices of the first year

Table 4 Assumptions for calculating economic surpluses in Brazil Colombia and Venezuela resulting from the associated planting of rice-pastures on 10 million ha

Asumptions	Rice	Beef	Milk
Initial equilibrium quantity (Q_0) (000 t)	13 964	6 666	17 795
Initial equilibrium price (P_0) (US$/t)	200	500	200
Price elasticity of supply (ε_p)	0 50	0 50	0 70
Price elasticity of demand (N_p^p)	-0 50	-0 60	-0 80
Minimum supply price (US$/t)	78	180	67
Annual rate of supply growth due to autonomous factors (K_a) (%)	1 5	1 5	1 5
Displacement factor of supply due to the technological change evaluated (K)	1 33	1 11	1 21
Annual rate of demand growth (K_d) (%)	1 5	1 5	1 5
Discount rate (%)	10 0	10 0	10 0

Table 5 Economic surpluses (US$ millions) due to technological change and autonomous factors in the adoption process of rice pasture associations on savannas (closed economy)

Product	Surpluses for the producer			Surpluses to the consumer			Total surplus		
	Tech	Autonom	Total	Tech	Autonom	Total	Tech	Autonom	Total
Beef	273 2	2,323 4	2 050 1	581 8	0	581 8	308 6	2 323 3	2 631 9
Milk	278 0	2 321 8	2 043 8	851 6	0	851 6	573 6	2 321 9	2 895 5
Rice	795 8	1,876 8	1 081 0	1 455 2	0	1,455 2	659 3	1 876 9	2 536 2
Total	1 347 0	6,522 0	5 174 9	2 888 6	0	2 888 6	1 541 5	6 522 1	8 063 6

Table 6 Value of the total economic surpluses[a] according to the yearly discount rate (10 million ha, US$ millions)

Annual discount rate (%)	Rice	Beef	Milk	Total
1	6 212 0	2 634 2	4 875 3	13 721 5
5	2 351 0	956 3	1 772 9	5 080 2
10	803 4	308 6	573 6	1 685 6
15	315 1	214 9	317 0	847 0
20	138 9	47 9	89 5	276 3

a Due to the technological change analyzed

Table 7 Value of the total economic surpluses[a] according to the duration of the diffusion period (10 million ha, US$ million)

Diffusion period (years)	Rice	Beef	Milk	Total
10	1 777 0	844 0	1 623 0	4 244 0
15	1 455 1	714 7	1 315 7	3,485 5
20	1,103 4	578 8	1 068 1	2 750 3
25	978 8	469 2	867 9	2 315 9
30	803 4	380 5	705 6	1 889 5
35	659 3	308 6	573 6	1,541 5

a Due to the technological change analyzed

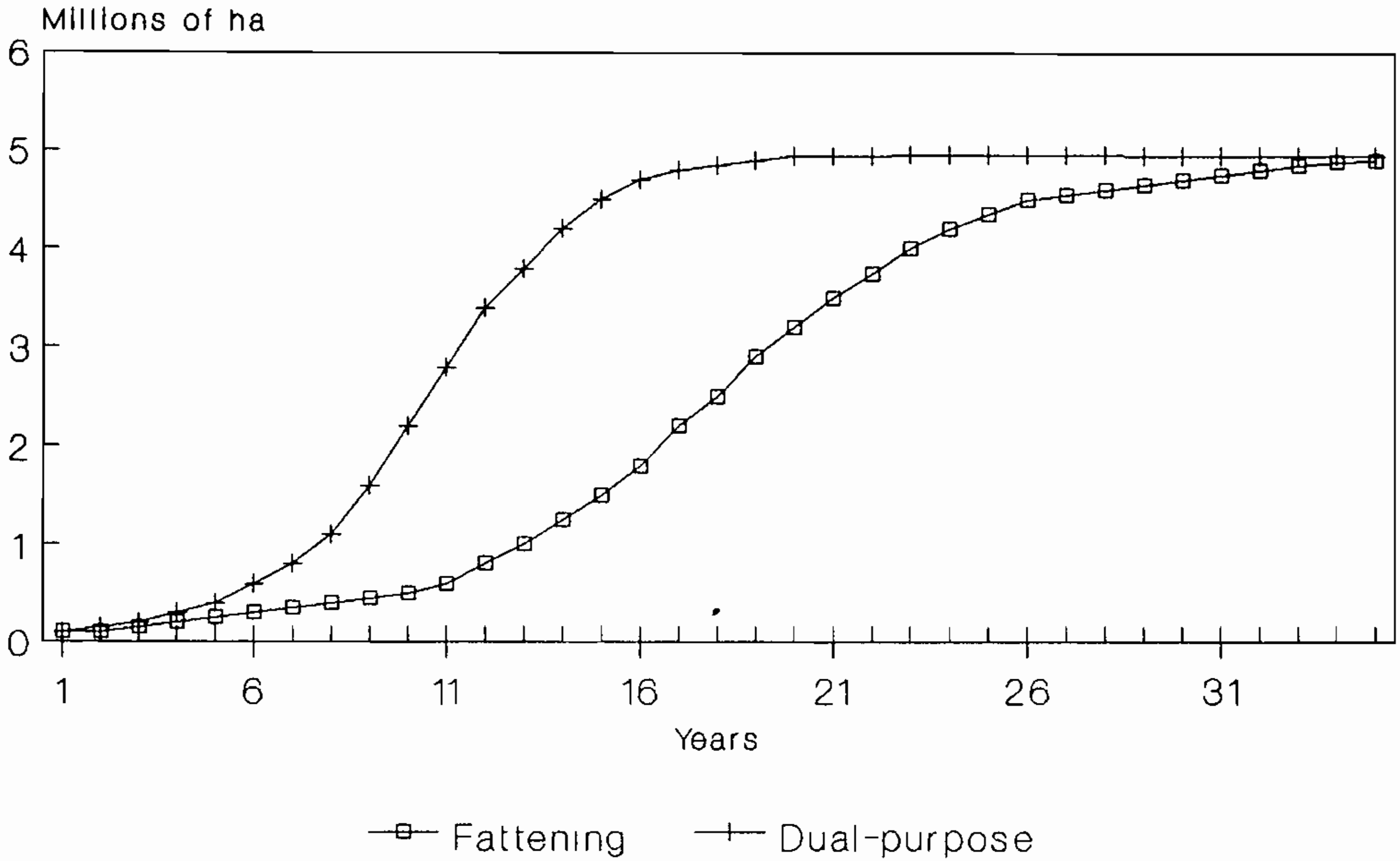
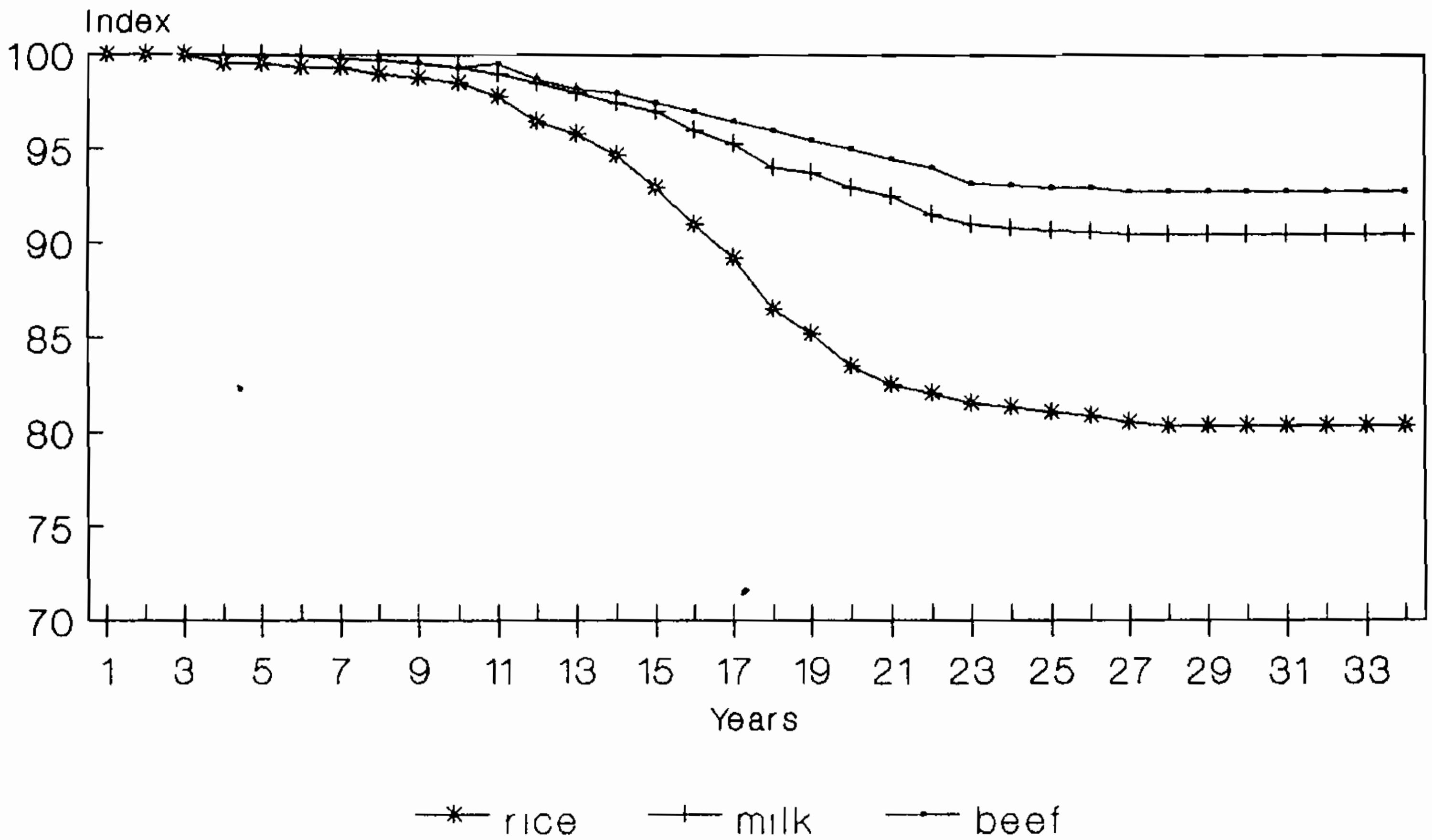


Figure 1 Evolution of the area with new technology dual-purpose and fattening activities



Basis of the index first year = 100

Figure 2 Index of the real price to the producer· rice, beef, and milk