Combined and changing effects of market incentives, technical innovations and support on maize production in Southern Mali

Michel Fok A.C.[α]
Mama Koné[β]
Hamady Djouara[β]
Abdoulaye Dolo[γ]

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Abstract

The paper analyses the evolution of maize production during the last two decades in Southern Mali, a region known mainly for its cotton production. Maize production actually took off during the first half of the 1980s as a result of a voluntary programme associating widespread and adapted technical support, effective input provision and guaranteed price under a compulsory state-controlled cereal trading. From 1986 while adoption of intensive maize sole cropping was in progress, the implementation of Structural Adjustment Policy through cereal market liberalisation and abolition of input subsidies firstly led farmers to return to traditional intercropping with decreased fertiliser use. Maize is showing again an increased contribution to food security from the beginning of the 1990s, in particular after the currency devaluation in 1994. Farmers are adopting more intensive maize sole cropping, to the extent of some specialisation at the expense of millet and sorghum. Our case study emphasises the need for long assessment of the impact of technical innovations along with changes in market incentives. State market control has helped introduce technical innovations farmers adopt again after market liberalisation provided input provision remains effective as it is within an integrated cotton production.

Keywords

Maize, Mali, innovation, market incentive, extension,

1. Introduction

Southern Mali is known mainly for its cotton production from around 160,000 smallholdings with an average area of 6 ha (CMDT, 1996). This makes Mali the second largest cotton producer and the leading exporter in Africa. Progress in food crop production in this region is becoming well documented. (Dioné, 1989) has underlined the improved performance in food security in Southern Mali while there is evidence of a larger cereal surplus for cotton farmers in comparison to those who do not grow cotton (CMDT, 1992,

[α] CIRAD, Programme coton, TA 72/09, 34398 Montpellier Cedex 5, France (email : michel.fok@cirad.fr)

[β] Institut d'Economie Rurale, BP 258, Bamako Mali (email : Espgrn.Sikasso@ier.ml)

[γ] Compagnie Malienne pour le Développement des Textiles, BP 487, Bamako, Mali

Raymond and Fok, 1994). In Mali, maize is making an increasing contribution to food crop production, accounting for a third of the total rainfed cereal production (Dembele, 1998). The increasing role of maize production has been emphasised more generally in many cotton areas of francophone African countries as a result of the present adoption of improved maize varieties (Bosc and Hanak Freud, 1994).

This paper is focused on analysing factors affecting maize production in Southern Mali over a period of more than two decades. The recording of maize production statistics began in 1977 by the cotton company, CMDT (Compagnie Malienne pour le Développement des Textiles, a para-state body established in 1974) in charge of rural development. At that time, there was 7,000 ha of "improved maize" (refered to application of at least one of the intensification techniques, organic manure, ploughing or mineral fertiliser) while maize was traditionally intercropped with millet or sorghum without any fertiliser application. In 1998, this figure had increased to 213,000 ha, intercropping was vanishing and some specialisation in one rainfed cereal was observable. Our analysis shows that this dramatic change is associated with a combination of technical innovations, technical support and market incentives whose characteristics however evolved considerably. The Malian experience is a case illustrating the need for long assessment of the impact of the introduction of a new technique and for long appraisal of such an impact along with the change in market incentives.

A reminder of the phase of a voluntary promotion programme in the early 1980s is followed by analysis of the production progress from the mid-1980s onwards, with market change related to the Structural Adjustment Policy (SAP). The lessons learnt from the Malian experience are discussed as a conclusion.

2. A comprehensive promotion programme with rapid impact

Agricultural stagnation in the Sub-Saharan countries is commonly associated with lack of technical innovations (Sanders, et al., 1996). However, such technical factors do not account for the maize production situation in Southern Mali as most of the technical messages existed there prior to their actual dissemination in the early 1980s. Indeed, the price factor has also been crucial. Focusing on the 1960-83 period, (Lecaillon and Morrisson, 1986) noticed a favourable trend in relative prices for cereal production only from the end of the 1970s. Such a trend would neither have been sufficient to sustain the present production increase through higher input. In Mali, the input:output price ratio has been more favourable for groundnut, but use of mineral fertiliser was far lower than for cotton (Lecaillon and Morrisson, 1986), tending to confirm that "…the development of fertiliser use has to be seen as a comprehensive and complex servicing task calling for continuing efforts over a considerable period of time, in the field of crop marketing, input distribution and technical support" (Gergeley, 1992).

In fact, the increase in maize production observed today in Southern Mali is related to the implementation of a comprehensive program promoting maize intensification through favourable trading conditions, technical innovations and specific, widespread technical support.

Although the cotton company (CMDT) claimed to have paid attention to food crop development 1976 onwards, specific means were actually allocated to this purpose in 1981 following the launching of a Maize Intensification Project (referred to as 'the Project') with French funding. This Project had several components mainly concerning: a) the implementation of adaptive research to bring new varieties and technical practices (a new farm was set up for this and for seed production), b) supply of credit to help farmers to

evolve towards mechanised agriculture (ox-drawn or motorised) and to help villages to obtain milling machines for grain processing.

The Project then focused on both the production level and the post-harvest level. It was run during a period of compulsory state-controlled cereal trading so that farmers were assured of a guaranteed outlet at a pre-determined price. In 1980, the Malian Government decided to ensure equal prices for maize, millet and sorghum, correcting the previous lower prices for maize. The Government went even further in 1982 and awarded a slight premium for maize in comparison with millet and sorghum. The price factor was obviously favourable and contributed to drawing farmers' attention to maize.

The Project helped to make new growing techniques known. These techniques were for maize sole cropping with varieties adapted to three rainfall levels. From 1980 to 1988, implementation of demonstration plots for intensified maize was made part of the monitoring tasks of the extension agents who had previously only handled cotton growing (more than 2,400 plots during the 1981-85 period). This program led to recommending a fertilising formula based on existing fertilisers still available for cotton. It has helped farmers to compare their own maize varieties to "improved" varieties under intensification techniques (based on higher plant density recommended prior to the Project implementation and adapted mineral fertilising from 100 kg of compound fertilizer and 150 kg of urea per hectare). Farmers' traditional techniques in their own fields were compared to the demonstration plots. The superiority of the improved varieties was confirmed in intensive cultivation: in 1982-85 period, mean yield was 2000-2900 kg/ha for local varieties, 2100-3100 kg/ha for "Tiemantié" a local variety the Malian Research recommended for a long time and 2600-3600 kg/ha for "Tuxpeno 1".

These improved varieties were not in fact as new as all that except for the most successful variety, "Tuxpeno 1", which was introduced from Côte d'Ivoire after originating at CIMMYT in Mexico. In a recent assessment of the impact of maize research, it was reported in 1998 that 27% of the maize plots in the CMDT zone, were planted with improved varieties, and respectively 37% and more than 50% of the farmers used the "Tiemantie" and "Tuxpeno 1" varieties (Diakité, 1998) in spite of the fact that new varieties had been introduced and disseminated in the meanwhile.

In short, the trading rules laid down for maize made it an attractive crop and there was also a technical support scheme to inform farmers about intensified ways of cropping it. Seed production has helped farmers to obtain improved varieties although the amounts sold (380 tons during the 1982-85 period) are a poor indicator of actual adoption of a variety. In addition to seed availability, chemical fertilisers were allocated on a credit basis and cumulated with the ordinary input credit awarded to cotton farmers: all the inputs used by a cotton farmer were paid back at the seed cotton marketing stage with no distinction between the destination crops.

In other words, maize production was promoted during the first half of the 1980s by a combination of favourable price and non-price factors. A guaranteed , higher price with state-controlled marketing of cereal grains acted as a strong market incentive. A widespread adaptive research program helped farmers to grow the crop effectively. The new technical practices demonstrated were accessible thanks to the organization for seed production and distribution while the whole input supply system benefited from the credit system for integrated cotton production. Farmers did respond to this combination of favourable factors, as is shown in Figure 1: a significant increase in maize hectarage was observable from 1982 to 1985. This is also acknowledged by (Boughton, et al., 1994) who, however, attributed this positive reaction mainly to greater development of ox-drawn agriculture.

Such an increase was subject to modification as a result of cereal market liberalisation associated with the implementation of SAP. Uncertainty about maize prices and a significant increase in fertiliser costs after a reduction of the subsidy resulted in a certain encouragement for farmers to return to traditional techniques.

3. Fluctuating progress of production under changing incentives

3.1. stagnation associated with market liberalisation and the abolition of subsidies

Implementation of the SAP has slowed the trend for an increasing role of maize in cereal production. With reserves concerning the reliability of production data provided by the CMDT company, in 1985 maize formed 40% of the total rainfed cereal production. This share declined sharply until 1987 and has now recovered to the previous record level owing to a dramatic change in 1996 (Figure 2).

The extent of the decline in 1986 was greater than one might expect from the change in the hectarage allocated to maize production (the maize share in total rainfed cereal hectarage dropped from 23% in 1985 to 20% in 1987); it was actually the combined result of some stagnation in hectarage and a more substantial decline in yield. The yield movements observed during the 1986-1989 period could hardly be attributed to climatic hazards alone. The reduction in the subsidy on fertilisers led to significant increase in their cost (Figure 3), implying a change in the way they were used.

Little research work was performed to monitor the ways farmers were growing cotton in the first half of the 1980s. (Berckmoes, et al., 1990) analysed maize development in one village, leading to questioning the intensification policy that was claimed to be in progress. Table 1 shows that prior to the implementation of the SAP, farmers' adoption of maize sole cropping was in progress. Subsequently, most farmers returned to a traditional form of intercropping. In terms of fertiliser use prior to SAP, the amounts actually applied on maize were still small compared to the recommendations (dating back to 1982/83) but they tended to be even smaller afterwards. With the reservation of the very small size of the survey sample, there is some evidence of a decline in maize intensification This is consistent with many analyses of the impacts of SAP in Sub-Saharan countries (Gergeley, 1992).

The implementation of SAP has led farmers to re-examining the benefit of intensive maize growing, in particular in the 2-3 following years. SAP has led to unstable maize prices, (Figure 4) while in comparative terms, as subsidies were reduced more for fertilisers than for insecticide (to prevent from failure in cotton protection), maize suffered more from a less favourable output:input ratio.

3.2. New progress dynamics linked to currency devaluation

Since the end of the 1980s, although maize growing slowly recovered a more substantial role in rainfed food crop production, the current conspicuous contribution of maize directly followed the devaluation of the CFA Franc in 1994 which was an integral part of the SAP.

There has been more information about the cropping systems in Southern Mali since the beginning of the 1990s. The CMDT is running its own survey scheme and has issued many reports about the evolution of cotton and food crop production. Research teams have also committed themselves to monitoring farmers' cultural practices and reactions to economic and social changes. A survey was implemented in 1997 and 1998 in 6 villages within 85 farm holdings and provides a clear picture of the increasing role of maize in secure food supplies and in complementing cash earnings.

According to our analyses (Fok, 1999, Koné, et al., 1998), maize is the only food crop to benefit substantially from organic manure, along with cotton (for instance, 50% and 26% of

cotton and maize plots respectively benefit from organic manure.) The same applies to the use of chemical herbicides. On average, maize forms 17.7% of the rainfed cereal area in the 6 villages but accounts for 27.5% of production. This is consistent with other sources (CMDT, 1997, Dembele, 1998). Our survey (Table 2) shows that maize plays a greater role in locations with higher rainfall expectations (villages of Danderesso, Ntena, Koumankou) or in those with a longer technical background in cotton growing (Dampela). This is connected to the yield gap between crop species on the one hand, and with maize yield expectation among villages on the other (Table 3). One original result was the emerging phenomenon of some kind of specialisation on maize growing in one village, involving 73% of the sample farms of the village. The same phenomenon can also be seen for cotton without endangering food security by larger cereal surplus (after deduction of 250 kg/inhabitant (Table 4).

Farmers' cultivation techniques have dramatically changed in terms of intercropping. Table 5 shows that intercropping, which was returning by 1987, is waning again at least as far as intercropping between cereals is concerned, while it was believed to be the method to which farmers were attached (Traoré, 1987) and whose decline was not at all anticipated because of farmers' aversion to risk (Kébé, 1987). Adoption of intensive maize sole cropping does not seem to be a consequence of a more favourable relative price towards cotton (Figure 4). This results deserves additional research work as it may correspond to a change in farmers' aversion to risk or to a new land allocation pattern between rainfed cereal crops according to their yield potential at the expense of millet and sorghum.

Besides, in comparison with the mid-1980s situation reported by (Berckmoes, et al., 1990), the use of mineral fertiliser on maize has significantly increased. This somewhat intensification of cereal growing is enabled by higher cash income from the cotton production, it is targeted at the maize production as farmers have observed by themselves how this crop respond positively to fertiliser use. Current fertiliser use is however still below the demonstrated dosage although there is variation between villages related to rainfall (Table 6). The current situation is the opposite to that anticipation by Boughton et al. (1994) shortly after devaluation, probably because of more favourable maize prices (in connection with higher demand from neighboring countries and from local market[1]) and farmers' adjustment to fertiliser use at below the recommended doses.

The reasons for farmers' new interest in maize production are basically economic. This assumption is supported by the economic profitability comparison made in our survey sample. The gross margin per hectare (defined as gross income minus chemical input costs) provides an indication of the productivity advantage in favour of maize among rainfed cereal crops (Table 7). This result is consistent with CMDT analysis of the positive effect of devaluation on farmers' incomes, whether farmers' adjustment in land allocation to the various crops are taken into account or not (Giraudy and Niang, 1996). (Kébé, et al., 1998) rather observed negative effects resulting from devaluation but their calculations are debatable as they assume ex-ante remuneration of farm labour and unchanged labour per unit in spite of a dramatic and systematic increase in cultivated area.

The prices of maize, sorghum and millet increased dramatically after the devaluation of the CFA Franc. Although it is variable, the maize price increase has been at least equal to the devaluation rate (Dembélé and Egg, 1999). It seems that, owing to attractive albeit variable

[1] Some poultry farming development as well as the launch of a new type of bread made of 85% of wheat flour and 15% of maize flour).

price expectation, farmers have become more receptive to cereal crop intensification and are using production techniques that were demonstrated in the past.

4. Conclusion: the lessons learned

In Southern Mali, maize production has increased dramatically during the past two decades, although diversely according to rainfall zones. Farmers' current favouring of maize sole cropping with fertiliser use is seldom reported. Although this relative intensification is favourable to help correct soil mining Budelman and Van der Pol (1992), Dean Girdis (1993) and Van der Pol (1990) have pointed out in Southern Mali, it is still insufficient to ensure cropping system sustainability.

The production increase was unsteady and had slowed by the mid-1980s before increasing strongly in the early 1990s. Farmers have also returned to traditional intercropping techniques to a certain extent after a short commitment to intensive production methods. The introduction of these methods was certainly favoured by a secure market outlet and fertiliser supplies. The availability of applicable technology is not enough to actually promote production. Our case study shows that farmers adapt their support for intensification in one direction or another according to changes in market incentives. In Mali, currency devaluation has provided as many market incentives to grow intensive maize as former rigid state-controlled guaranteed cereal trading, but it was thanks to the maintenance of favourable fertiliser supply conditions within an integrated cotton production scheme: this is an additional evidence of possible synergy between cash and food crops.

The impact of technical innovations could hardly be assessed without taking the economic environment into account. As this environment can change considerably, it is worthwhile to underline the need for time to assess the actual value of a technical innovation. What farmers have learned is not totally lost even if they do not use it. In our case study, a favourable economic and organizational environment has led to very rapid, positive impacts as Bond (1983) has pointed out more generally. We should however acknowledge that the Malian maize experience is somewhat exceptional. Farmers' widespread adoption of sole cropping of maize with greater fertiliser use could be related to an astonishing change in their aversion to risk. This question merits further examination.

Table 1 : Evolution of the maize intensification pattern among 9 farmers

Village	Maize sole cropping		Maize interpcropping		Amount of fertiliser (kg/ha)		
	number farmers	hectarage (ha)	number farmers	hectarage (ha)	compound	urea	total
1982	6	0,57	9	1,71	30	5	35
1983	8	1,18	6	0,91	48	34	82
1984	4	1,02	7	1,41	50	24	74
1985	2	0,24	9	2,85	58	22	80
1986	2	0,46	9	2,01	59	27	86
1987	2	0,24	9	2,23	44	17	61

Source : Berckmoes et al., 1989

Table 2 : Maize contribution to rainfed cereal hectarage and production

Village	Contribution to hectarage		Contribution to production	
	Maize specialisation ?		Maize specailisation ?	
	No	Yes	No	Yes
Dampela	23%		46%	
Danderesso	59%	100%	70%	100%
Kacienso	7%		11%	
Koudougouni	6%		7%	
Koumankou	30%		44%	
Ntena	12%		20%	
Average	18%	100%	28%	100%

Source : Fok et al. 1999

Table 3 : Rainfed cereal yields in the sample villages

Village	Crop		
	Maize	Millet	Sorghum
Dampela	2509	914	914
Danderesso	2194		1084
Kacienso	886	384	559
Koudougouni	1211	1038	892
Koumankou	1424	588	688
Ntena	2047	813	758
Average	**1924**	**798**	**774**

Source : Fok et al. 1999

Table 4 : Cereal surplus and relation with cotton and maize growing

Village	Cereal surplus in farms regarding maize specialisation (Kg/inhabitant)			Cotton share in cropping systems
	No specialisation	with specialisation	All farms	% total hectarage
DAMPELA		354	354	25%
DANDERESSO		286	286	42%
KACIENSO	16	74	70	25%
KOUDOUGOUNI	255	337	306	19%
KOUMANKOU	75	206	198	48%
N'TENA	68	-44	-22	33%
Total	**157**	**195**	**191**	**33%**

Source : Fok et al. 1999

Table 5 : Abandon of intercropping in progress

Crop	% of plots under	
	Intercropping	Monocropping
Maize	23%	77%
Millet	1%	99%
Sorghum	5%	95%

Source : Fok et al. 1999

Table 6 : Mineral fertilizer use on maize

Village	Amount of mineral fertilizer (kg/ha)		
	Urea	compound fertilizer	total
Dampela	81	95	176
Danderesso	53	99	152
Kacienso	15	77	92
Koudougouni	13	52	65
Koumankou	49	115	164
Ntena	26	85	111
Total	**50**	**91**	**141**

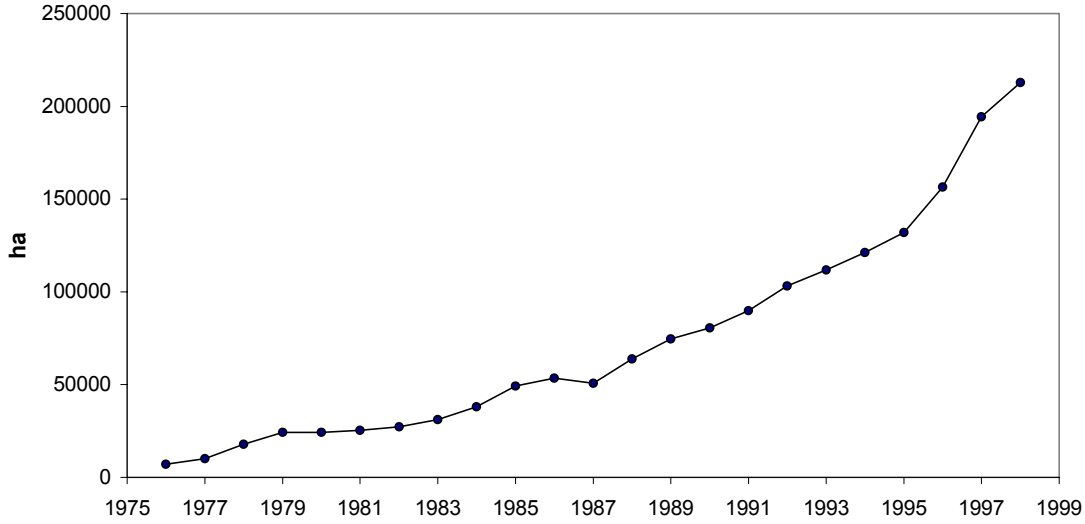
Source : Fok et al. 1999

Table 7 : Gross margin comparison for the main rainfed crops (CFA Franc/ha)

Village	Main rainfed crops			
	Cotton	Maize	Millet	Sorghum
Dampela	208 531	153 423	76 555	65 738
Danderesso	184 308	134 358		80 519
Kacienso	156 155	47 923	37 151	45 815
Koudougouni	145 051	77 670	100 706	71 598
Koumankou	219 177	74 099	58 833	58 284
Ntena	149 108	131 267	81 300	59 891
Total	**184 037**	**116 247**	**73 599**	**61 188**

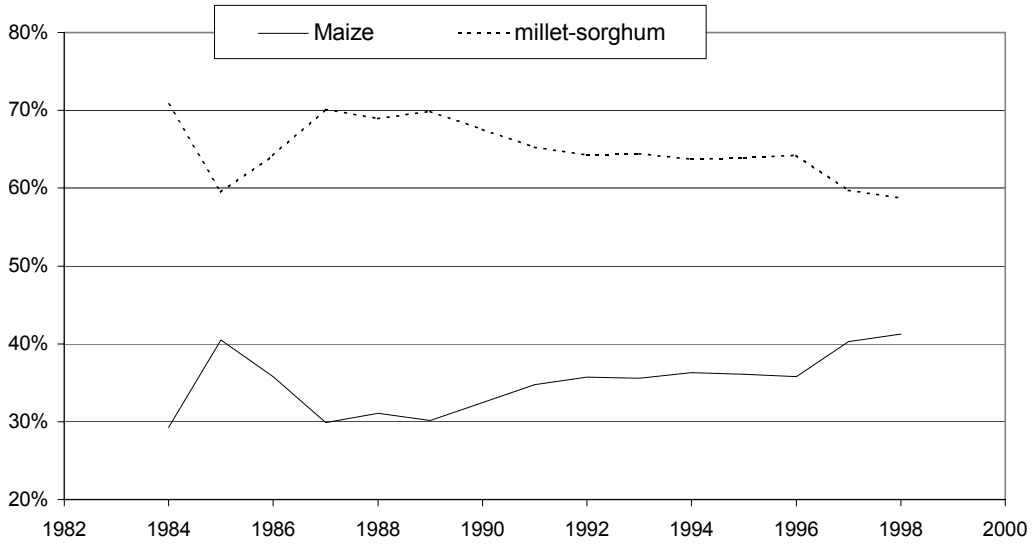
Source : Fok et al. 1999

Fig. 1: Maize hectarage in the CMDT zone, Southern Mali



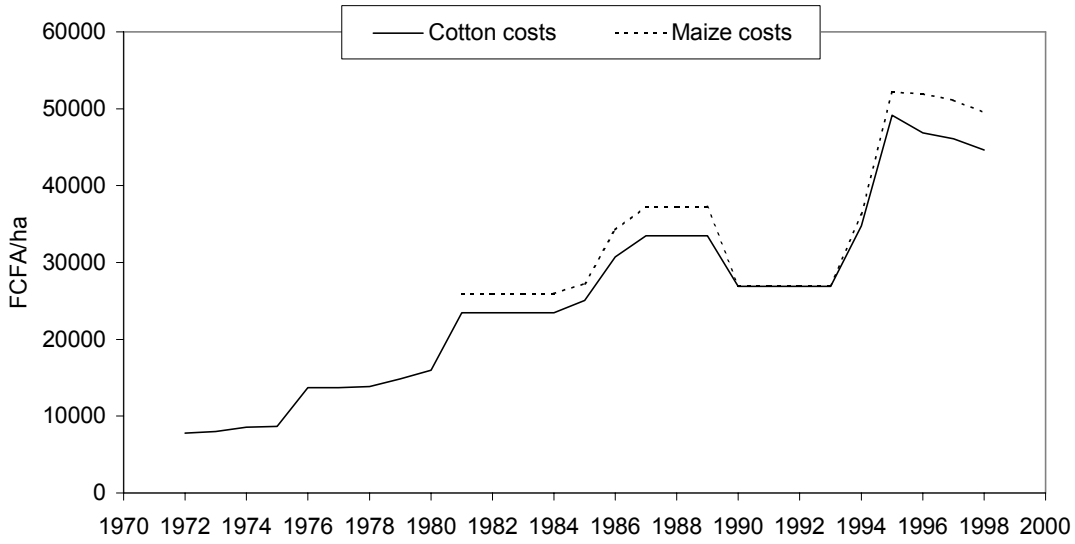
Source : CMDT

Fig. 2: Maize and millet/sorghum respective contribution to rainfed cereal production



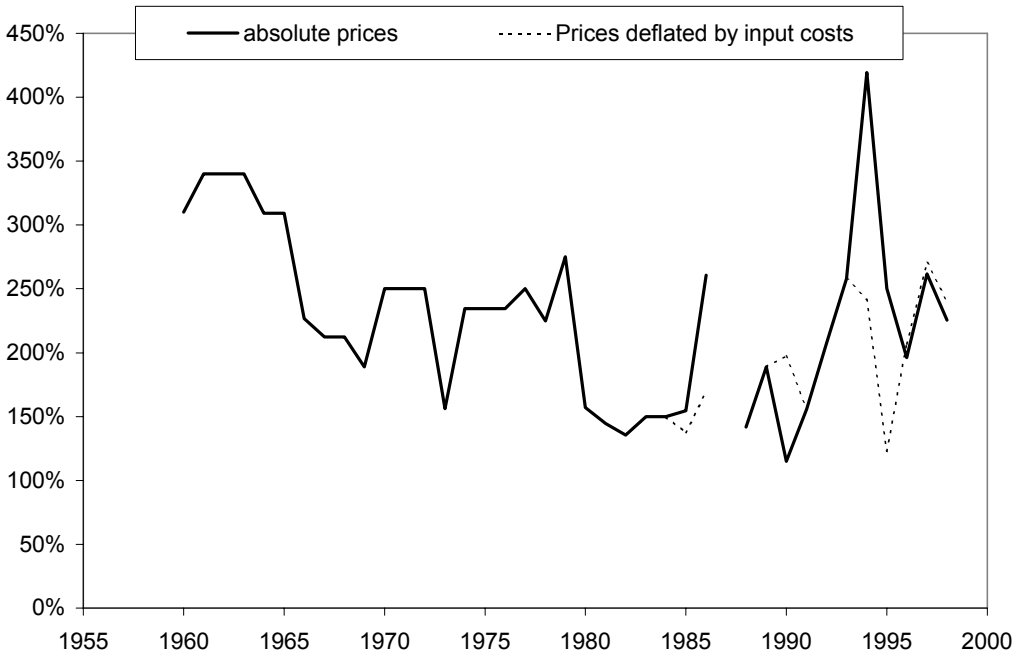
Source : CMDT

Fig. 3: Evolution of total input costs for cotton and maize production (FCFA/ha)



Source : CMDT

Fig. 4 Price ratio of cotton over maize



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