Socio-economic Assessment of Pesticide Use in Mali

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AV	Association Villageoise (Village Associations)
BCEAO	Banque Centrale des Etats de l'Afrique de l'Ouest (Central Bank of the West African States)
BNDA	Banque Nationale de Développement Agricole (National Bank for Agricultural Development)
CFA	Communauté Financière Africaine (African Financial Community)
CFDT	Compagnie Francaise de Développement des Textiles (French Company for the Development of Textiles)
CIF	cost, insurance, freight
CILSS	Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (Inter-governmental Permanent Committee for the Combat of Drought in the Sahel)
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (Center for International Cooperation in Agricultural Research for Development)
CMDT	Compagnie Malienne pour le Développement des Textiles (Malian Company for the Devleopment of Textiles)
CNGP	Comité National de Gestion des Pesticides (National Committee for Pesticide Management)
CPS	Contribution pour Prestation de Service (Contribution for Service Delivery)
CSP	Comité Sahélien des Pesticides (Pesticide Committee of the Sahel)
DGD	Direction Générale des Douanes
DGRC	Direction Générale de la Réglementation et du Contrôle
DNA	Direction Nationale de l'Agriculture
DNACPN	Direction Nationale du Contrôle de Pollutions et des Nuisances
DNAMR	Direction Nationale de l'Appui au Monde Rural
DNI	Direction Nationale des Industries
DNS	Direction Nationale de la Santé
DNSI	Direction Nationale de la Statistique et de l'Informatique
DPRPAV	Division Prévention des Risques et Protection Animale et Végétale
EC	Emulsifiable Concentrate
ECOWAS	Economic Community of West African States
éq.	Equivalent
EU	European Union
FAO	Food and Agriculture Organization of the United Nations

FOB	Free On Board
GATT	General Agreement on Trade and Tariffs
GNP	Gross National Product
ha	hectare
IER	Institut d'Economie Rurale
INRSP	Institut National de Recherche en Santé Publique
INSAH	Institut du Sahel
IPM	Integrated Pest Management
IPM-CRSP	Integrated Pest-Management - Collaborative Research Support Program
kg	kilogram
KR2	Kennedy Round 2
L	Liter
LEC	Lutte Etagée Ciblée
Max.	Maximum
Min.	Minimum
MPC	Mali Protection des Cultures
NGO	Non-Governmental Organization
OHVN	Office de la Haute Vallée du Niger (Office
PRODIMAL	Société des Produits Insecticides du Mali (Society
RECOMA	Représentation Commerciale au Mali (Economic Representation in Mali)
ROCAFREMI	Réseau Ouest et Central-Africain pour la Recherche sur le Mil (West and Central African Network for Millet Research)
ROCARS	Réseau Ouest et Central-Africain pour la Recherche sur le Sorgho (West and Central African Network for Sorghum Research)
SMPC	Société Malienne des Produits Chimiques (Malian Society of Chemical Products)
SNPV	Service National de Protection des Végétaux (National Crop Protection Service)
TV	Tons Villageoises (Village Groups)
TVA	Taxe sur la Valeur Ajoutée (Value-Added Tax)
ULV	Ultra Low Volume
US $	United States Dollar
USAID	United States Agency for International Development
UEMOA	Union Economique et Monétaire Ouest-Africain (Economic and Monetary Union of West Africa)
VAT	Value-Added tax
WHO	World Health Organization
WTO	World Trade Organization

Preface

The study on „Socio-economic Assessment of Pesticide Use in Mali“ conducted by an inter-disciplinary, inter-agency and gender-sensitive team of pesticide policy experts that includes O.C. Ajayi, M. Camara, G. Fleischer, F. Haïdara, M. Sow, A. Traroré und H. van der Valk adds another example to the list of country studies conducted under the framework of the Pesticide Policy Project at Hannover University. The study in Mali is the fourth such report for Africa.

The study of Mali is of particular interest from a development economics perspective as it analyzes the pesticide question in the context of an economy that has not been able to free itself from its historical dependence on a single crop: cotton! The report impressively portrays how the structural adjustment policies of the early nineties have effected changes in many crops but that at the same time the government keeps its hands on cotton. This is not surprising as cotton remains the major source of foreign exchange of the country. On the other hand, the report also shows the link between macro-economic polices and the pesticide use problem in a country in West Africa. While in many of the other crops productivity gains were achieved without a rise in pesticides this turned out to be exactly opposite in cotton. Through a complex system of indirect and hidden subsidies farmers have been driven into a pesticide spiral resulting in costs to the national economy. It is these interrelationships which are made transparent in an excellent manner in the Mali study. The team of authors must be commended for unwinding these complex issues in a readily accessible and easily understandable way. They show that it is possible to reach such conclusions even though the data base is scanty. Therefore the authors' second major contribution is to clearly outline where more in-depth analysis would be of tremendous value for national and international development organizations who support agricultural development in Mali.

The study poses a challenge to improve the policy planning process on the sector level when implementing rural development frameworks.

Hannover, February 2002

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Acknowledgements

This report summarizes the findings of a nine-month collaborative activity between the Institut du Sahel (INSAH), Bamako, and the GTZ/University of Hannover Pesticide Policy Project. The study was started at a time when it became apparent that trends in pesticide use should be analyzed in a comprehensive manner that could benefit appropriate decision-making in Mali and in other CILSSS countries.

This study could not have been carried out without the help of many persons involved in the fields of agriculture, environment, health protection and economic evaluation in Mali. We greatly acknowledge their openness and willingness to discuss pesticide use and policies. It would be impossible to thank them individually on this page. This general, but very sincere, acknowledgement is addressed to all of them.

Our specific gratitude goes to the Division Prévention des Risques et Protection Animale et Végétale (DPRPAV) and the Direction Générale de la Réglementation et du Contrôle du Secteur Agricole (DGRC), both part of the Ministry of Rural Development, the Direction Nationale de l'Assainissement et du Contrôle des Pollutions et Nuisances (DNACPN) of the Ministry of Rural planning, Equipment, Environment and Urbanism, the Compagnie Malienne pour le Développement des Textiles (CMDT), and the Office de la Haute Vallée du Niger (OHVN).

The active support during the entire study by the Secretary-General of the Ministry of Rural Development, Mamadou Goïta, is highly appreciated. Amadou Diarra (Institut du Sahel) and Cheikh Hamallah Sylla (FAO) contributed during many different stages of this study. Their assistance is gratefully acknowledged.

Financial support for this study was provided by the Global IPM Facility (Rome), the Swiss Development Cooperation, and the FAO Pesticide Management Project for the Sahel.

The participants in the workshop on pesticide use and policies in Mali, in September 2000, contributed valuable insights to this assessment for which we would like to thank them.

The authors

February 2002

Summary

Mali has witnessed a positive development of its agricultural sector in the last decade. The devaluation of the CFA franc in 1994 supported an increase of domestic cereal production and a renewed competitiveness of exports on international markets. Mali has become the second-largest cotton producer in Africa after Egypt with a production of over 500,000 tons in 1998.

For a long time, the use of chemical pesticides has been regarded as a crucial factor for controlling pests and improving agricultural productivity. This has been especially the case for cotton production which has benefited from promotion of supervised pest control by the parastatal development organizations. However, there is limited knowledge about the environmental and economic impacts of current pesticide policies and its potential alternatives. This study provides an in-depth analysis of the economic and institutional factors that shape pesticide use and policies in the country.

The government adopted a liberalization policy in agricultural development in the 1980s. Product marketing and input supply were progressively handed over to the private sector, with the exception of cotton. The cotton development agencies CMDT and OHVN hold monopolies for the marketing of cotton and for input supply in cotton growing areas. Pesticides are delivered on credit to farmer associations. Input costs are recovered from the receipts farmers get after cotton harvest.

Pesticides are considered goods of primary necessity for agricultural production within the regional trade schemes. Imports benefit from reduced tariffs and are exempted from sales tax.

Following requirements set by international conventions and global commodity markets, Mali is currently in the process of putting regulatory measures in place that allow for better control of imports, distribution and use of pesticides. A regional pesticide registration scheme was set up among the CILSS countries. Pesticide management is expected to improve after an inter-ministerial committee will have been established.

Pesticide imports increased substantially during the last decade. Volumes grew from 1,800 tons in 1991 to 4,100 tons in 1999. In value terms, imports increased from about 2 billion CFA francs between 1991 and 1993 to over 12 billion CFA francs in 1999. The share of insecticides is more than 50 % of the total imports. The pesticide market is still larger than the data on import gathered from official statistics show because of local formulation of pesticides based on imported active ingredients and due to an unknown amount of illegal

imports. For 1998, the market is estimated to have reached 5,400 tons of formulated pesticide products with an estimated value of about 17 billion CFA francs (US $ 25 million).

About 90 % of total pesticides is distributed by three government-controlled organizations, namely CMDT, OHVN and DNAMR. Pesticide use is concentrated on a few crops among which cotton with 80 % of pesticide use is the most important. Insecticide use in cotton grew substantially since 1995 because of area expansion and the development of pest resistance and secondary pests. Insecticide costs for cotton farmers increased from about 15,000 CFA francs to 27,000 CFA francs per hectare. Higher producer prices were masking the impact of increasing pesticide costs at the farm level, but only until the recent cyclical downward trend in international cotton markets took place.

Pest resistance against pesticides and secondary pest development have to be recognized as serious threats to the competitiveness of Malian cotton production on international markets. On average, cotton farmers spent nearly 6 billion CFA francs in 1998 more on insecticides compared to the early 1990s, when corrected for the area expansion. Increase of pesticide use has been accompanied by a decrease in cotton yields, further hurting profitability.

Although there is a lack of qualified information about other crops, it is clear that pesticide use on cereals did not increase during the last decade despite substantial growth of crop yields and production. The lack of data is particularly problematic for vegetable and fruit production where pesticide use conditions are often described as anarchic. Herbicide use dominates in rice production at a level of low intensity. The government provides subsidized pesticides for cereal production and migratory pest control in the framework of the KR2 program of the Japanese donor agency.

The evaluation of the external costs of current pesticide use levels could only be partially fulfilled due to a lack of reliable statistics. Nevertheless, the available data show that the true costs of pesticides for the society at large are at least 40 % higher than the private costs actually paid by the farmer. Costs of pest resistance and secondary pest development as well as human health costs are the most important components.

Alternatives to pesticide use have been adopted only to a limited scale. CMDT adopted a scheme of reduced insecticide use, called “Lutte Etagée Ciblée” on about 4 % of its cotton growing area. Finding a level of pesticide use which brings the benefits of crop protection in line with a reduction of negative effects of pesticides on human health and the environment. Adoption of IPM has to be

considered as a long term strategy for the future in pest management in order to secure agricultural productivity and protect the environment and human health.

Policies for promoting more rational pesticide use and a progressive adoption of alternatives to unilateral dependency on chemical pesticides should include a reversal of direct and indirect subsidies and other support measures for pesticides, further tightening of regulatory control and enforcement, which needs commitment and instruments for sustainable financing, the internalization of external costs into pesticide prices in order to provide incentives for reduction of unnecessary use, investment in research and development of non-chemical alternatives, and training and awareness raising among farmers, extension workers and consumers.

Further research should be conducted on the economic and environmental impact of different crop protection strategies at the level of individual crops. The monitoring system for health and environmental impact of pesticide use has to be improved in order to allow more detailed economic evaluation of pesticide externalities.

Résumé

Au cours de la dernière décennie, la production agricole au Mali a connu une évolution positive notable. La dévaluation du franc CFA en 1994 a supporté une reprise de la production céréalière au niveau national et a amélioré la compétitivité des exportations sur les marchés internationales. Le Mali est devenu le deuxième producteur de coton graine en Afrique, après l'Egypte, avec une production de 500 000 tonnes enregistrée en 1998.

L'utilisation des pesticides fut longtemps considérée comme un facteur crucial de lutte contre les nuisibles et d'amélioration de la productivité agricole. Ce phénomène est remarquable particulièrement pour les cultures de rente, comme le coton, qui ont bénéficiées d'une promotion de lutte supervisée par les sociétés d'encadrement. Cependant, peu est connu des effets environnementaux et économiques des politiques actuelles d'utilisation des pesticides, ou leurs alternatives. Une analyse approfondie est présentés ici des facteurs économiques et institutionnels qui influencent la politique et l'utilisation des pesticides au Mali.

La libéralisation du secteur agricole fut amorcée au milieu des années 1980 par une série de restructurations des secteurs étatiques. Elle s'est soldée en particulier par la participation des opérateurs économiques privés dans la commercialisation des produits. La filière cotonnière est la seule à échapper jusqu'à présent à la libéralisation des prix des intrants et du coton graine. Les prix du coton au producteur continuent d'être fixés par les structures d'encadrement pour le coton, la CMDT et l'OHVN. Les produits phytosanitaires sont en général cédés aux producteurs à crédit et leur prix est prélevé en fin de campagne sur les revenus réalisés sur la vente du coton.

Les pesticides sont classés parmi les produits de première nécessité pour la production agricole au Mali. Par conséquent, ils bénéficient d'une tarification réduite à l'importation, et sont ex honorés de la TVA.

Incité par des conventions internationales et la globalisation du marché des produits agricoles, le Mali a accentué, au course de la dernière décennie, le renforcement des mesures réglementaires pour le contrôle d'importation, de distribution et d'utilisation des pesticides. En outre, un système régional d'homologation de ces produits a été mis en place par les Etats membres du CILSS. Des changements substantiels sont attendus dans la gestion des pesticides au Mali notamment avec la création du Comité National de Gestion des Pesticides qui est une structure interministérielle.

Les importations de pesticides ont considérablement augmenté entre 1991 et 1999. Elles sont passées de 1 800 à 4 100 tonnes durant cette période. Les valeurs de ces importations se sont chiffrées à 12 milliards de francs CFA en 1999, alors qu'elles n'étaient que d'environ 2 milliards entre 1991 et 1993. En valeur, les insecticides constituent la part la plus importante des importations de pesticides, représentant plus de 50% du total des importations.

L'estimation du marché total des pesticides est plus élevée, car elle inclue la formulation locale à partir des matières actives importées, ainsi qu'une quantité inconnue d'importations illégales. Ainsi, en 1998, le volume du marché était environ de 5400 tonnes de produits formulés, avec une valeur estimée à 17 milliards de francs CFA (25 millions $ E-U).

Trois structures d'Etat représentent à elles seules plus de 90 % de l'utilisation totale des pesticides au Mali: la CMDT, l'OHVN et la DNAMR. Le coton domine la filière, consommant 80 % de l'ensemble des pesticides. L'utilisation d'insecticides dans le coton a beaucoup augmenté depuis 1995, à cause de l'expansion de la superficie cultivée et le développement de la résistance et des ravageurs secondaires. Les coûts d'insecticides au niveau du paysan sont augmentés de 15 000 francs CFA au 27 000 francs CFA à l'hectare durant cette période. Mais les prix plus élevés du coton ont compensé pour une grande partie l'impact d'accroissement des coûts de pesticides. Toutefois, cette tendance change actuellement avec la détérioration des cours du coton sur le marché international.

La résistance aux pesticides et le développement des ravageurs secondaires devraient être reconnus comme des dangers sérieux pour la compétitivité de la production du coton malien sur les marchés internationaux. Les producteurs de coton ont dépensé, en moyenne et en tenant compte de l'expansion de la superficie cultivée, 6 milliard de francs CFA de plus en pesticides en 1998 par rapport au début des années 1990. Cette augmentation d'utilisation des pesticides à été accompagnée par une réduction des rendements du coton, affectant d'avantage les revenus nettes.

Bien qu'il existe un manque de données détaillées pour les autres spéculations, il est clair que l'utilisation des pesticides sur les céréales n'a pas augmenté durant la dernière décennie, malgré une accroissement substantiel des superficies cultivées et des rendements. Le manque de données est particulièrement aigu pour les cultures maraîchères où l'utilisation des pesticides est souvent qualifiée comme anarchique. Dans la production du riz les herbicides dominent, mais jusqu'à maintenant à une faible intensité. En outre, le gouvernement fourni des pesticides subventionnés pour les céréales

sèches et pour lutte antiacridienne et antiacridien, dans le cadre du KR2, programme d'appui du gouvernement du Japon.

L'évaluation des coûts externes de l'utilisation des pesticides n'a pu être effectuée que partiellement, due à une manque de statistiques fiables. Toutefois, les données disponibles montrent que les coûts sociales des pesticides sont au moins 40% plus élevés que les coûts privés payés en actuellement par les agriculteurs. Les composant les plus importants de ces coûts cachés sont la résistance aux pesticides, le développement des nouveaux ravageurs et les coûts de santé.

Des alternatives aux pesticides ont été adopté seulement à une échelle limitée. La CMDT applique un système d'utilisation réduite de pesticides, la "Lutte Etagée Ciblée", sur environ 4% de ses superficies sous coton. Cependant, il sera de plus en plus important de trouver un niveau d'utilisation des pesticides qui réuni les bénéfices en protection des végétaux avec une réduction des effet néfastes sur la santé humaine et l'environnement. L'adoption de la gestion intégrée des ravageurs devrait être considérée comme la stratégie future pour la protection des végétaux, afin de d'assurer une production agricole durable ainsi que la protection des ressources naturelles et la santé humaine.

Plusieurs mesures devraient être adoptées pour promouvoir une utilisation plus rationnelle des pesticides et une adoption progressive des alternatives à la dépendance unique sur les pesticides chimiques. Elles incluent: la réduction des subventions directes et indirectes sur les pesticides; le renforcement de la législation et du contrôle de l'utilisation des pesticides, demandant un engagement important de l'Etat et des moyens durables de financement; l'internalisation des coûts externes dans les prix des pesticides, afin de pouvoir donner des intensives à leur utilisation plus optimale; l'investissement dans la recherche et le développement des alternatives non-chimiques; et la sensibilisation et formation des agriculteurs, vulgarisateurs et consommateurs.

En outre, il est recommandé que la recherche soit renforcé dans le domaine de l'impact économique et environnementale des stratégies différentes de protection des cultures dans les principales filières. Le système de suivi de l'impact des pesticides sur la santé humaine et l'environnement devrait être renforcé, afin de permettre l'évaluation plus détaillée des externalités économiques de l'utilisation de ces produits.

1 Introduction

Agricultural intensification is considered, especially since the devaluation of the CFA franc in 1994, to be the preferred strategy to maintain agricultural competitiveness and ensure food security in the African Sahel, and in Mali in particular. This intensification is characterized by an increased use of agricultural inputs such as pesticides. In spite of these developments, Africa accounts still only for a very small fraction of world wide pesticide use. In 1994 and 1995, the continent represented about 2% of the global pesticide market (WRI, 1998; FAO, 1998). However, available statistics certainly provide an underestimate of use patterns in sub-Saharan Africa, as has been shown in a recent study of the CILSS countries (van der Valk and Diarra, 2001). Moreover, little is known about the environmental and economic impacts of current use levels in this region as pesticide use is typically concentrated on a few cash crops, mostly for export.

The globalization of the economy, and the increased awareness about the negative impact that pesticides may have on human health and the environment, have forced developing countries aspiring to increase their importance on the world agricultural commodity markets to revise their practices and policies in pesticide management. This is also the case in Mali, which has recently reinforced pesticide legislation and control and is developing several initiatives to implement integrated pest management.

Given the increased importance of pesticides in agricultural production, little attention has been given, in Mali or any other country in the Sahel region, to an evaluation of the economic determinants of pesticide use and its related policies. The present study aims to partly fill this gap and contribute to the elaboration of a national pest management strategy, within the framework of sustainable food security and agricultural development in Mali. Studies that follow the same objective have been elaborated for Ivory Coast (Fleischer *et al*., 1998; Ajayi 2000) and for Ghana (Gerken *et al.*, 2001).

The methodology used in this study follows the one developed by the GTZ/Hannover University Pesticide Policy Project (Agne *et al*., 1995). It is based on the application of economic decision criteria to the use of pesticides, both for the individual agricultural producer as for society as a whole. In analyzing policies that contribute to the distortion of pesticide use from its socially optimal level, several price and non-price factors have to be taken into account. Pesticide subsidies can artificially lower the price of pesticides and provide incentives for unnecessary use. The current legal environment and

regulatory framework may be inadequate and dysfunctional which has an impact on the occurrence of environmental and health damage. In most cases, external costs are not included in the price of pesticides which presents the end-users with inappropriate incentives for overuse of pesticides. Priorities of organizations dealing with research, education and extension in pest management might favor chemical control over other technological options. Quantitative and qualitative information on the magnitude of the economic and institutional distortions that have an impact on current pesticide use levels is expected to facilitate decision making at policy level toward more rational pesticide policies. The objectives of this study are to:

- review pesticide use in the main agricultural sub-sectors and evaluate its determinants;
- carry-out an inventory the private and external costs of pesticide use;
- provide elements for a cost-benefit analysis of pesticide use in the main agricultural sub-sectors;
- contribute to the political decision making process about sustainable agricultural development.

The report is organized as follows:

Chapters 2 and 3 provide a description of the agricultural sector in Mali. This is followed by an analysis of the changes in agricultural policies which have taken place in the recent past and their influence on the sector. Chapter 4 describes the regulatory framework for pesticide production, distribution and use in Mali.

In chapter 5 an attempt is made to quantify the pesticide market in Mali and its development over the last 10 years. This is followed by a description of the main actors with respect to pesticide distribution and use in the country. Chapter 6 provides a more detailed analysis of pesticide use in the main agricultural sectors. Chapter 7 attempts to inventory and quantify both direct and indirect costs of pesticide use in Mali. Conclusions and recommendations can be found in chapter 8.

The report is based on a more detailed study which was published previously in French by the Institut du Sahel (Camara *et al.*, 2001). We refer to that report for a more profound discussion of some of the subjects, especially the development of agricultural production and the assessment of externalities. The period covered by this study is from 1990 to 1999, unless specified otherwise.

2 Characteristics of the agricultural sector

2.1 Trends in economic development

Mali belongs to the group of the least developed countries in West Africa. Since a large part of the country is covered by the Sahara desert and the adjacent Sahel zone, Mali has suffered from the impacts of the drought in the early 1970s. After macro-economic adjustment, economic development improved in the 1990s. Gross national product (GNP) in 1999 was US $ 240 per capita, however growing at an average annual rate of 2.7 % (World Bank 2000).

Other indicators for quality of life underline the low level of development which is however slightly higher than in most of the neighboring countries. Child malnutrition stands at 27 % of children under the age of 5. Forty-four percent of males and 69 % of females above the age of 15 are illiterate. Population grew at an average annual rate of 2.5 % between 1980 and 1990, and 2.8 % between 1990 and 1999 (World Bank 2000).

More than 72% of the total population of 10 million is rural. Approximately 4 million rural people are considered to be economically active (DNSI, 2000c). Agriculture occupies 95% of this economically active rural population, though only for about 6 months per year. Like in many other West African countries, there is a population movement from the rural areas to the cities, mostly by the younger people.

2.2 Importance of the agricultural sector for the economy of Mali

The Malian economy depends to a large extent on the agricultural sector. Agriculture contributes slightly less than half of the gross domestic product (GDP). This share has been more or less constant over the last 10 years (see Table 2.1).

Food crops make up the largest fraction of agricultural GDP attaining 31% in 1999 (Table 2.2). Cotton contributed 16 % to agricultural GDP. There is a downward trend in the importance of food crops, while the contribution of cotton has increased over the last 10 years.

Table 2.1: Contribution of the different economic sectors to GDP (in billion CFA francs, constant prices of 1987)

Year	Total GDP	Share of total GDP (%) covered by :			
	(factor costs)	Agriculture	Mining	Industry	Services
1990	626	48	2	13	37
1991	622	46	2	14	38
1992	678	49	2	15	39
1993	637	47	2	14	37
1994	669	49	3	14	36
1995	706	50	2	14	35
1996	727	47	2	15	36
1997	774	47	5	15	35
1998	809	46	6	14	35
1999	862	47	6	13	35
2000	906	47	6	13	34

Source: DNSI (2000a)

Agricultural commodities represent more than 44% of total exports in 1999 (Table 2.3). However, their relative contribution is decreasing in favor of mining products. Almost all of the agricultural exports is cotton (>99.5%).

Table 2.2: Contribution of the different sub-sectors to agricultural GDP

Crop	Year									
	90	91	92	93	94	95	96	97	98	99
Agricultural GDP (billion CFA francs, constant 1987 prices)	306	289	334	299	327	351	345	361	370	404
Food crops, except rice[1] *(%)*	39	33	38	32	35	37	33	30	28	31
Rice *(%)*	7	6	8	9	8	8	8	11	9	11
Cash crops, except cotton[2] *(%)*	3	3	3	2	3	3	3	2	2	2
Cotton *(%)*	11	14	12	13	9	11	15	16	18	16
Livestock	27	29	26	29	30	27	26	26	27	26
Fisheries	3	3	3	3	3	3	3	3	4	3
Fruits, forest products	10	12	10	12	12	11	12	12	12	11

[1] millet, sorghum, maize, potato, beans, yam, cassava, fonio

[2] groundnut, tobacco, wheat

Source: DNSI (2000a)

Horticultural exports have increased over the last years, notably green beans and mango. The export of cereals shows large fluctuations between the years because of the climatic variations.

Table 2.3: The share of various products as a percentage of total exports and total imports, from 1995 to 1999.

Products	Year				
	95	**96**	**97**	**98**	**99**
Total exports (in billion CFA francs)	221	221	327	328	328
of which:					
Agricultural products * (%)	59	61	49	44	44
Livestock and fisheries (%)	19	15	11	10	10
Gold and diamonds (%)	16	18	36	41	41
Others * (%)	6	6	4	5	5
Total imports (in billion CFA francs)	385	393	439	448	463
of which :					
Food products (%)	14.4	14.1	14.7	16.3	13.8

*Note: the export of fruits, vegetables and cereals is included in the section «Others»

Source: DNSI (2000b)

The high importance of cotton for the economy of Mali is underlined by comparing cotton revenues with the total imports and government revenues (Table A-2.1 in the annex). Receipts from cotton exports contribute more than 30% to the financing of total imports, and are worth more than 50% of government revenues. This fraction is fairly stable, and no clear positive or negative trend can be discerned over the last decade.

2.3 Agricultural production in Mali

About 50 % of the total area of 1,241,231 square kilometer lies in the Sahara desert, with less than 150 mm annual rainfall. Livestock keeping for subsistence is the main economic activity in that region. Agriculture is in principle feasible in the remaining area of the country. Quantity and pattern of annual rainfall determine the cropping pattern (see Table 2.4)[1].

[1] More details are found in Camara *et al.* (2001).

Table 2.4: Agro-ecological zones in Mali

Zone	Share of total area in %	Annual rainfall in mm	Main crops	Problems
Sahel	23	150 – 600	Millet, sorghum, fonio, rice, groundnut	Soil degradation due to demographic pressure on land
Sudan	18	600 – 800	Millet, sorghum, cotton, maize, rice, vegetables	Reduction of soil fertility
Sudano-guinean	6	> 800	Cotton, sorghum, groundnut, rice, vegetables, fruits	Presence of tse-tse fly hampers agricultural development
Delta of the Niger	3	250 – 800	Rice, sorghum, vegetables	Rational management of irrigation

The main crops being produced in Mali are cereals and cotton. Cereal production has greatly increased, showing approximately 40 % growth over the last decade for the five major cereal crops (Table 2.5). This growth is mainly due to two factors: Yields for all cereals improved on average, combined with the increased importance of high-yielding crops, such as rice and maize, at the expense of lower-yielding ones, such as millet. The total area being cultivated with cereals has actually decreased by 20% over the same period, and amounted to about 2.1 million ha in 1998. In terms of food availability, Mali is now self-sufficient in cereals and it exports some quantities to neighboring countries.

The production of the major cash crop in Mali, cotton, has almost doubled since 1990 (Table 2.5). Contrary to the improved performance of the cereals, cotton production growth is entirely due to area expansion (going from 205,000 ha in 1990 to 504,000 ha in 1998). Cotton yields have actually dropped by 23% over the same period.

Comprehensive national statistics for fruits and vegetables are not yet available. However, market estimates suggest an important growth for these crops as well, especially over the last 5 years.

Table 2.5: Production and yield of the main crops, 1990 to 1999

Crop	Growing season								
	90/91	**91/92**	**92/93**	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**
Area (x 1000 ha)									
Rice	197	263	233	246	284	303	324	336	323
Millet	1213	1075	1061	1346	1404	1286	936	646	911
Maize	170	186	192	257	284	205	181	275	232
Sorghum	809	707	934	1031	977	851	541	830	615
Fonio	48	56	31	40	54	46	24	48	20
Cotton	205	215	246	200	269	336	420	497	504
Total production (x1000 tons)									
Rice	282	454	410	428	469	463	614	577	705
Millet	737	890	582	708	898	707	739	649	814
Maize	197	257	193	283	322	264	290	392	385
Sorghum	537	770	602	777	746	710	540	776	599
Fonio	22	41	21	30	19	22	15	24	16
Cotton	276	273	320	241	293	406	452	523	517
Average yield (tons/ha)									
Rice	1.43	1.73	1.76	1.73	1.65	1.53	1.89	1.71	2.18
Millet	0.6	0.1	0.5	0.5	0.6	0.6	0.8	1.0	0.9
Maize	1.2	1.4	1.0	1.1	1.1	1.3	1.6	1.4	1.7
Sorghum	0.7	1.1	0.6	0.8	0.8	0.8	1.0	0.9	1.0
Fonio	0.5	0.7	0.7	0.8	0.4	0.5	0.6	0.5	0.8
Cotton	1.34	1.27	1.30	1.20	1.09	1.21	1.08	1.05	1.03

Sources: CPS (1998); DNAMR (1999, 2000)

2.4 Summary

Agriculture is an important sector of the Malian economy, contributing nearly half of the GDP. Despite the climatic risks and the dependence on world markets for the main cash crop, it is evident that agricultural development remains the main pillar in future economic development. Especially cotton holds an exceptional position with regard to export revenue.

Cotton and rice production have shown dramatic increases during the last decade. However, the area increase masks the declining trend in cotton yields which is likely to hurt future profitability.

3 Agricultural Policy Framework

After independence in 1960, Mali adopted a socialist system characterized by a large influence of the state on agricultural production and trade. Commodity prices were fixed by the government, and generally kept low to benefit consumers in the cities. In the mid-1980s, mainly due to the burden of high external debt, the government started to withdraw from direct engagement in economic activities. For instance, the production and commercialization of all agricultural commodities, except cotton and tobacco, was liberalized as of 1987. Reforms under the Adjustment Program for the Agricultural Sector, which was initiated in 1988 and supported by the World Bank, further aimed to increase productivity and competitiveness. Private initiative is now actively promoted.

3.1 Trade policy

The current trade policy of Mali is, apart from ensuring the supply of national markets, focused on the promotion of export products. Within the agricultural sector, policies aim to strengthen productivity and competitiveness as well as the promotion of the production of a diversified range of agricultural export commodities.

Mali became member of GATT in 1993 and subsequently of the WTO in 1995. It is considered a “least developed country” within WTO, and benefits from a differential and more favorable treatment. Mali is also a member of the Economic Community of West African States (ECOWAS). ECOWAS promotes the liberalization of inter-community trade, through the suppression of all non-tariff barriers and a progressive reduction of tariff barriers for products originating in ECOWAS countries.

Similarly, the Union Economique et Monétaire Ouest-Africain (UEMOA), of which the country is also a member, advocates the free circulation of goods, services, capital and persons within the Union. A common tariff, the “Tarif Extérieur Commun” (TEC), is since 2000 applied to most products being imported from outside the UEMOA zone (Table 3.1).

Imports of agricultural commodities from within the UEMOA are exempted from customs duty. This is also the case for industrial products which have been produced for a large part within the Union (if 60% of raw materials originates from, or an added value of 40% has been achieved, within the

Union). The latter is probably the case for certain pesticides which have been formulated within the UEMOA zone (e.g. in Senegal or Côte d'Ivoire).

While intermediate products are generally taxed as Category 2 goods, agricultural inputs (including pesticides) and machinery imported from outside the UEMOA zone are considered to be goods of first necessity, and taxed as Category 1 products.

Value added tax (VAT) is presently also being harmonized to a common UEMOA level which would lie somewhere between 15 and 20%. However, VAT is not been applied to agricultural inputs (Table 3.2).

Table 3.1: Import tariffs in Mali (in %) for all categories of products, as of 1 January, 2000.

Product category	Type of tax				
	DD	PCS	PC	RS	TDP & TCI
0 Goods of social character (e.g. medicines, books, food)	0	0.5	0.5	1	Products, levels and duration of these tariffs determined by the Council of Ministers
1 Goods of first necessity; raw materials; capital equipment	5	1	0.5	1	
2 Intermediary products	10	0.5	0.5	1	
3 Goods for final consumption; other goods	20	0.5	0.5	1	

DD = customs duty; PCS = community (UEMOA) solidarity tax; PC = tax going to ECOWAS; RS = statistical levy; TDP = degressive protection tax; TCI = variable import tax (Taxe Conjoncturelle à l'Importation).

Source: Customs Directorate (Sous-direction des recettes et des études)

Table 3.2 shows the development of import taxes on agricultural inputs, such as pesticides, since 1990. Apart from a temporary increase in 1999, import taxes have been relatively stable, and are now 7.5%. For certain pesticides formulated within the UEMOA zone, import taxes would only amount to 2.5%, if the proportion of local value added is at least 40 %, or if at least 60 % of inputs are produced locally.

For the matter of comparison, table 3.2 shows the evolution of tax rates on the import of agricultural commodities. The compound taxes (import and value added tax combined) have therefore decreased from approximately 50% in the early nineties to about 39% over the last two years (exceptions were made, however, for the import of rice, in certain years).

Table 3.2: Development of import tariffs and value added tax (VAT) (%) on agricultural commodities and inputs from 1990 to 2000

Taxes	Year										
	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**
Agricultural inputs											
All import taxes	6	6	6	6	6	6	6	6	6	11	7.5
VAT	0	0	0	0	0	0	0	0	0	0	0
Agricultural commodities											
All import taxes	36	36	36	36	36	36	36	36	36	16	17,5
VAT	10	10	10	10	10	10	10	10	10	18	18

Source : Customs Directorate (Sous-direction des recettes et des études)

Since 1990, all commercial exports are free of export taxes. Only cotton exports are subject to a service delivery charge (Contribution pour prestations des services, CPS) of 5 %.

3.2 Development strategies for the major agricultural sub-sectors

The level of government support to agricultural production in the principal sub-sectors varies widely. It focuses, to different degrees, on credit facilities, on the commercialization of agricultural products, and on the modalities how farmers get access to agricultural inputs. Training and extension also are part of this strategy, but are not further discussed here.

3.2.1 Cotton

Cotton production in Francophone Africa on a commercial scale started during the 1920s in Chad. Later on, it was pioneered during the colonial period in other countries by the French parastatal Compagnie Francaise de Développement des Textiles (CFDT). After independence, cotton production continued to be promoted by national parastatal companies, with equity participation and Board representation by CFDT. Technical assistance, especially for research on seed development and testing is provided by the French research organization Centre de Coopération Internationale en Recherche Agronomique pour le Developpement (CIRAD) (Pursell, 2001).

Given its importance for the economy of Mali, cotton production is still closely guided and supervised by the parastatal cotton development organizations Compagnie Malienne pour le Développement des Textiles (CMDT) and Office de la Haute Vallée du Niger (OHVN). However, both organizations are progressively disengaging themselves from certain activities, such as cotton

area surveying, and storage and distribution of agricultural inputs. These tasks are now taken over by the Village Associations (AV) in the cotton-growing zones.

In the CMDT and OHVN zones, most of the agricultural inputs, such as pesticides, and agricultural equipment, such as pesticide sprayers, can be obtained with credit. Credit is most often provided by the Banque Nationale de Développement Agricole (BNDA), in cooperation with the cotton development organizations and the AV. Current short-term interest rates are 11%. All cotton produced is being sold by the farmers to the CMDT or OHVN, and credit is automatically recovered from the payments done by these organizations.

The types of seeds, fertilizers and pesticides are decided by the cotton development organizations with the advice of CIRAD and the national research organization. Extension services to cotton farmers, including especially advice on spraying schedules and doses, are provided by the cotton development organizations' own extension staff.

3.2.2 Rice

Since the restructuring of the various rice development organizations (e.g. Office du Niger, Opération Riz Mopti, Périmètre irrigué de Sélingué), which concentrate mainly on irrigated rice, many accompanying activities have been transferred to the village associations and "Tons Villageoises" (TV) or to private enterprises. This includes the provision of credit, the supply of agricultural inputs and equipment, and the transformation and commercialization of rice.

The development organizations limit themselves currently to major infrastructure work, such as the construction and maintenance of irrigation canals and perimeters. Contrary to the situation in irrigated rice, the production of traditional rice hardly benefits from any accompanying development activities except for the regions where the cotton development organizations are active.

3.2.3 Other cereals

The production of other cereals does not benefit from any intensive accompanying development activities except for the cotton growing areas. CMDT sells fertilizer and certain pesticides (herbicides and fungicides) to farmers in its intervention zones. However, there is currently no specific extension effort regarding cereal crops.

Since the early 1990s, the distribution of fertilizers and pesticides for cereals is privatized. However, there are some exceptions. Government-controlled input prices are valid in the CMDT zones and for so-called “KR2 pesticides” (see below). In case of migratory pest outbreaks (e.g. granivorous birds and migratory locusts), the DPRPAV provides state funded pest control in all of Mali.

3.2.4 Fruits and vegetables

The fruits and vegetable sector benefits only to a limited degree from development activities for production and marketing. A producer cooperative has been created for this sector which is covering a limited number of growers. Cooperative input supply has been used by part of the growers (UNCPM, 1995). Separate projects are implemented by NGOs, some AVs in the intervention zones of the cotton and rice development organizations and by individual large-scale growers.

Pesticides for fruit and vegetable production are almost entirely obtained from local markets. Also, a parallel market exists where cotton pesticides are provided by cotton farmers to fruit and vegetable producers (Traoré, undated). Cotton farmers sell leftover stocks of unused cotton pesticides, mostly insecticides, in case of urgent cash needs. The use of those pesticides in fruit and vegetable production can pose increased risks for health and environment since many products are specifically formulated for cotton production, but not for general use. Even if those products are in principle suitable for vegetable and fruit production, growers have little or no knowledge about the recommended dosage and the required waiting period before harvest.

3.3 Exchange rate policy

In 1994 the CFA franc was devaluated by 50%. The main objective was to restore the competitiveness of the export sector in the UEMOA countries. Most of the agricultural sub-sectors which had already liberalized their markets before the devaluation, noted positive effects. Domestic price increases were transmitted to the producer level and a considerable improvement of farmer revenues was observed. For instance, from 1994 to 1997, revenues increased by 100% for maize farmers, 75% for millet/sorghum growers and 63-78% for rice producers (Tefft *et al.*, 1998).

Only in cotton, where commodity prices continued to be fixed by the parastatal agencies, were revenue increases of farmers more limited (Etudes et

Recherches Sahéliennes, 1997). They amounted to 47-89%, over the same period.

Agricultural inputs prices increased considerably after the devaluation. An exception were cotton pesticides, whose sales prices to the farmer were kept relatively stable by the CMDT (see below).

3.4 Producer prices for agricultural commodities

After producer price liberalization in the 1980s, currently only the prices of cotton remain fixed by the government. Cotton producer prices are based on a preannounce floor price, which is negotiated in a three-year time frame with the cotton development organizations, plus a supplementary payment ("ristourne") which depends on the world market prices of cotton and on the financial situation of CMDT and OHVN. This system has provided the government, the cotton development organizations, and the farmers with a stabilized incentive framework that mitigates volatility at international markets. However, the system comes with costs for the national economy as the same floor price is guaranteed throughout the year and for all zones. The monopoly encourages rent seeking and mismanagement of resources by the parastatal agencies, generally at the expense of the farmers and the national budget (World Bank, 1999).

The administered cotton pricing system leads to indirect taxation of producers. The ratio of domestic to international prices has been among the lowest in the world. Malian producers received 52 % of the lint-equivalent of international seed cotton prices from 1990-93, while the ratio fell to 35 % in the period 1994-97. Towards the end of the 1990s, somewhat higher ratios were achieved, but these did not prove sustainable as the financial problems of CMDT in the year 2000 showed. During the 16 years between 1983/84 and 1998/99, on average cotton prices were 37 % higher in Zimbabwe and 60 % higher in India than in Mali (Pursell, 2001).[2]

In spite of the taxation, prices paid to the farmer have remained relatively competitive compared to other crops, for most of the last 10 years, which has encouraged production (Table 3.3). Floor prices increased 3.8% annually, on average, since 1994.

[2] The calculations do not include the different level of input subsidies in the three countries.

Table 3.3: Development of prices paid to farmers for selected a agricultural commodities in Mali (in CFA francs / kg)

Commodity	Year									
	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
Grain cotton - Ist choice	93	95	85	97.5	130	155	155	170	185	150
of which :										
floor price	*85*	*85*	*85*	*85*	*125*	*125*	*125*	*140*	*145*	*150*
premium	*8*	*10*	*0*	*12.5*	*5*	*30*	*30*	*30*	*40*	*0*
Paddy rice	84	87	56	61	79	94	117	109	123	115
Millet	34	54	47	57	47	63	98	85	105	71
Sorghum	34	49	42	52	42	62	99	87	98	86
Maize	29	43	35	41	36	58	83	75	80	90
Fonio	102	81	81	102	95	95	117	126	135	140
French beans	78	55	55	78	63	65	75	80	84	86

Source: CMDT (2000a), DNSI (2000a)

Prices of cereals have all gone up considerably since the liberalization of the markets and the devaluation of the CFA franc in 1994 (Table 3.3). Rice prices increased at an average annual rate of 9 % between 1994 and 1999. Malian rice is far more competitive to imports from the world market reaching the Senegalese port of Dakar, despite a considerable import tax reduction in 1995 (Mariko *et al.*, 1999).

3.5 Price policies for agricultural pesticides

The distribution and sales of pesticides has been liberalized together with other agricultural inputs, since the late 80s. Pesticides were distributed free of charge by the Ministry of Agriculture to cereal farmers until about 1993.

Presently, the sales of two types of pesticides are influenced by other forces than the market, those sold for cotton production and those distributed through the KR2 program.

Table 3.4 shows the price development of various types of cotton pesticides during the last decade. Sales prices to the farmer were kept stable until about 1994. One observes during this period that the gross margin (difference between CIF purchasing price and the sales price to village organizations) was often negative, showing that cotton pesticides were subsidized. This is not the case anymore after 1994. Purchasing prices went up considerably, due to the devaluation of the CFA franc. Also, sales prices started to fluctuate more and

seem to better reflect actual pesticide costs. However, the gross margins listed in Table 3.4 have to cover the costs of customs duties, transport, storage and distribution to the farmer. Since no data were available for the actual costs of these activities, it is difficult to assess whether cotton pesticide prices should still be considered subsidized.

Table 3.4: Development of purchasing[1] and sales prices of certain pesticides distributed by the CMDT, from 1990 to 1998 (in CFA francs / liter)

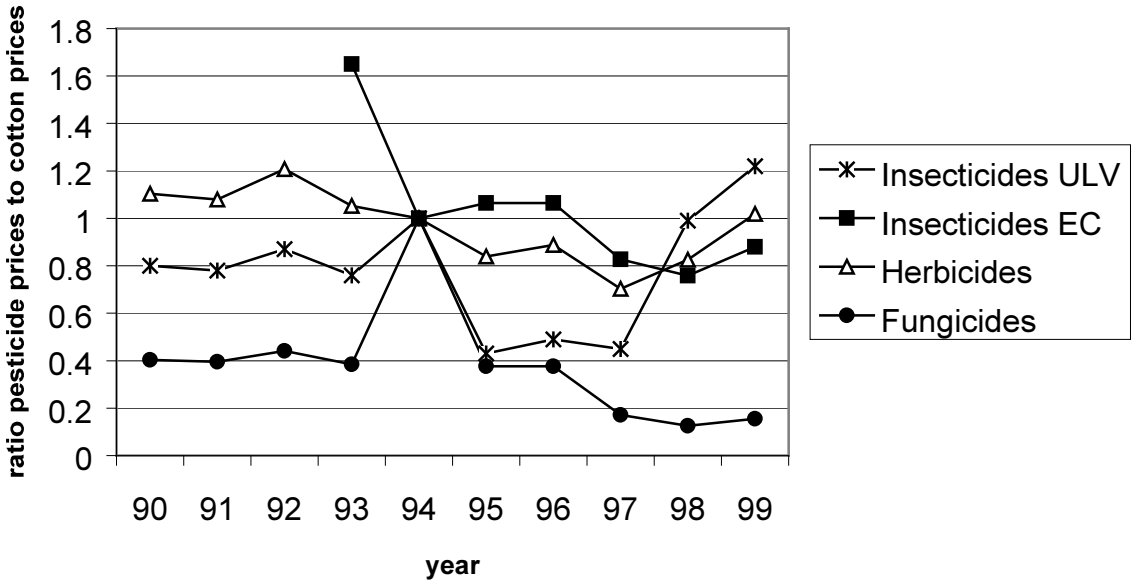
Pesticide	Growing season								
	90/91	**91/92**	**92/93**	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**
Cotton insecticide ULV									
Purchasing price	1 561		1 331	1 050	1 967	--- [3]	---	---	---
Sales price	1 300	1 300	1 300	1 300	2 275	1 335	1 335	1 335	---
Gross margin	*-261*	*-165*	*-31*	*+250*	*+308*				
Cotton insecticide EC									
Purchasing price	---	---	---	2 032	3 380	3 232	3 265	2 910	3 189
Sales price	---	---	---	3 900	3 150	4 000	4 000	3 405	3 400
Gross margin				*+1863*	*-230*	*+768*	*+735*	*+495*	*+211*
Maize herbicide									
Purchasing price	1 801	3 765	1 512	1 432	4 817	3 163	2 914	2 742	n.d. [4]
Sales price	2450	2450	2450	2450	3640	3640	3075	3000	n.d.
Gross margin	*+649*	*-1315*	*+938*	*+1018*	*-1177*	*+477*	*+161*	*+258*	
Rice herbicide									
Purchasing price	3 296	3 470	3 195	2 950	---	6 120	6 100	6 400	n.d.
Sales price	3 305	3 305	3 305	3 305	3 270	6 580	6 360	6 400	n.d.
Gross margin	*+9*	*-165*	*+110*	*+355*		*+460*	*+260*	*0*	

[1] considered to be the price CIF; [2] sales price to cotton farmer; [3] ---: type of pesticide not purchased or sold during this year; [4] n.d.: no data available

Source: CMDT (2000b)

In spite of the increased costs of pesticides to the farmer, the ratio of the price indices of cotton paid to farmers compared with the sales price of cotton pesticides has generally increased after the devaluation of the CFA franc in 1994 (Figure 3.1). This means that cotton farmers have had a greater incentive to use pesticides after the devaluation than before.

Figure 3.1: Ratio of pesticide prices to cotton prices from 1990 to 1999



Source: CMDT (2000a, 2000b)

Pesticides which are provided under the Japanese KR2 program may also create a market distortion, but for a different reason. These pesticides are bought by the Government of Mali with Japanese development funds. They are to be sold at 2/3 of the FOB price for which they were purchased, to constitute a counterpart fund for local development projects. Under the KR2 agreement, the Government of Mali is, in principle, obliged to make up for any deficits in this fund.

A comparison of prices of some KR2 pesticides with those available on local markets in Mali during a survey in the year 2000 revealed that there is a considerable difference between the official sales price of KR2 pesticides and the one applied by the government service responsible for the sales to farmers (see Table A-3.1 in the annex).

KR2 pesticides seem to be more expensive than the same products on the free market. It was suggested that this may be due to the tender procedures applied by the program. Whatever the reason, it would mean that public Japanese funds for development cooperation are used less efficiently than they could be.

Furthermore, if KR2 pesticides are sold cheaper than they should be to constitute the counterpart fund, this deficit needs to be made up from other means. That could be done by selling other inputs but pesticides (fertilizers and equipment) provided through KR2 more expensively, or by using

government funds. The latter would mean that Malian government funds, which might be needed elsewhere, are used to compensate for the deficit.

3.6 Summary

After ending the interventionist period in economic development in the early 1980s, government agencies progressively retracted from intervention in agriculture during the same period. The major agricultural sub-sectors of Mali gained in productivity and competitiveness after the liberalization and the devaluation of the CFA franc in 1994. Producer prices and incomes improved significantly, also compared to pesticide prices.

However, in the cotton sub-sector a monopoly for marketing and delivery of inputs is still held by two parastatal development organizations in their respective zones. This has important consequences for the pesticide market as about 80 % of the total imports is used in the zones of CMDT alone. Pesticides benefit from preferential treatment in the import duty and sales tax regime. Additionally, there are – to a not yet known extent - direct and indirect subsidies for cotton pesticides through the credit scheme and through the distribution channel of the cotton development organizations.

4 Pesticide regulation in Mali

The production, distribution and use of pesticides is regulated by various legal instruments, issued by several ministries. The institutional structure for pesticide regulation and control is still under development.

4.1 Main instruments and structures for regulation and control

4.1.1 Sub-regional level

Since 1992, pesticide registration became the responsibility of CILSS, with the introduction of the Common Pesticide Regulation. This Regulation was revised in 1999 and has now the status of a regional convention (CILSS, 1999). No national pesticide registration takes place anymore in any of the nine CILSS member states.

The executive body of the Common Pesticide Regulation is the Sahelian Pesticide Committee (CSP). It consists of technical experts from all member states[3]. The CSP evaluates the submissions for registration made by industry and approves or refuses (temporary) registration for the region.

Mali has modified its national pesticide legislation to take into account the provisions of the Common Pesticide Regulation.

4.1.2 National level

Before 1995, Mali did not have a national pesticide legislation. It referred to international bodies and regulations instead, such as the Interafrican Phytosanitary Council and the FAO Code of Conduct on the Distribution and Use of Pesticides.

In 1995, the law regulating agropharmaceutical products, and its accompanying decree, were adopted, creating a legal basis for regulation of pesticides in Mali (Table 4.1)

The Direction Générale de la Réglementation et du Controle du Secteur Rural (DGRC), of the Ministry of Rural Development, is responsible for the implementation of this legislation. This Directorate has regional branches and is also represented on the local level in Mali.

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[3] Member states are the following: Burkina Faso, Cape Verde, Chad, Gambia, Guinea Bissau, Mali, Mauritania, Niger, Senegal.

Furthermore, a Comité National de la Gestion des Pesticides (CNGP), is foreseen in national legislation, but not yet created. The CNGP is to function as an inter-sectoral platform which advises on and controls policy regarding pesticide use in Mali. It also will ensure the link to the sub-regional pesticide registration committee (CSP).

Aspects of environmental pollution, including those related to pesticides, will be regulated by the Law on environmental pollution (now in draft) (Gouv. Mali, 2000a). The Direction Nationale de l'Assainissement et du Contrôle des Pollutions et des Nuisances (DNACPN), of the Ministry of Equipment, Regional Planning, Environment and Urbanism, is responsible for application of this law.

The development of national norms and standards (e.g. in residues food or the environment) are the formal responsibility of the Direction Nationale de l'Industrie (DNI), of the Ministry of Industry, Commerce and Transport. However, since no national norms on pesticides currently exist, international standards tend to be applied.

4.2 Legislation for pesticide management

Table 4.1 lists the various legal instruments available to regulate and control various aspects of the life-cycle of a pesticide in Mali.

Pesticide experimentation is regulated under the Common Pesticide Regulation. Experimentation which is carried out in the region is mostly limited to efficacy testing and certain environmental evaluations. Experimental use permits for pesticides can be obtained under the national pesticide law. The Institut d'Economie Rurale (IER) is currently responsible for pesticide efficacy testing. With the further implementation of the Common Pesticide Regulation, it is expected that pesticide experimentation will increasingly be carried out in the region.

Table 4.1: Legislation on the different aspects of pesticide management in Mali

Legislation regulating the activity	Type of activity				
	Experimentation	Production	Distribution & sales	Use	Disposal
CILSS Common Pesticide Regulation (CILSS, 1999)	X		X	X	
Law N° 95-061 on the registration and control of pesticides (Gouv. Mali, 1995a)	X	X	X	X	
Decree N° 95-404/P-RM on the registration and control of pesticides (Gouv. Mali, 1995b)	X	X	X		
Draft Law on the control of environmental pollution (Gouv. Mali, 2000a)		X			X
Decree N° 99-189/P-RM on environmental impact assessment (Gouv. Mali, 1999)		X			
Draft Decree on the management of liquid waste (Gouv. Mali, 2000b)		X			
Draft Decree on the management of solid waste (Gouv. Mali, 2000b)					X

Source: own compilation, based on Camara *et al.* (2001)

Production and formulation of pesticides is only allowed in Mali if the product has been registered for use by the CSP. Any production, formulation or repackaging facility needs to be licensed by the Ministry of Industry, Commerce and Transport and receive an authorization of the Ministry responsible for the Environment. In addition, the construction of such a facility is subject to an environmental impact assessment.

Pesticides which are not registered by the CSP cannot be imported, distributed or sold in Mali. Any person involved in the distribution and sale of pesticides requires a license from the Ministry of Industry, Commerce and Transport as well as an authorization by the DGRC. The latter is also responsible for the enforcement of these regulations. Though improving over the last few years, the enforcement of distribution and sales restrictions appears to be one of the weakest links in the regulation of pesticides management in Mali. This is mainly due to a lack of training and regular funding.

Pesticides can only be used in Mali if registered by the CSP. A Ministerial Order is being prepared, but not yet adopted, to further regulate the actual use of pesticides.

The disposal of obsolete and leftover pesticides, as well as of empty pesticide containers, is subject to the national environmental legislation. Furthermore, since Mali is a signatory to the Basel Convention, it follows the provisions for the transboundary movement of obsolete pesticides contained in this convention.

4.3 Conclusions

A large array of legal instruments has been put in place over the last five years to regulate the entire life-cycle of a pesticide in Mali. Given the recent creation of these regulations, enforcement is still relatively weak. However, it is expected that pesticide management will improve in the near future as many additional instruments which have been already prepared will be actually implemented. However, the degree of enforcement of regulations depends on sustainable financing mechanisms for those activities. Those have not yet been established as only part of the costs is covered by service fees, e.g. for registration and residue analysis.

It is likely that the range of pesticides available in the market will decrease as a consequence of the full implementation of the regional registration scheme. Whether this decrease translates itself into higher pesticide prices and a reduction of use will be subject of further analysis in the future.

5 Pesticide trade, distribution and use in Mali

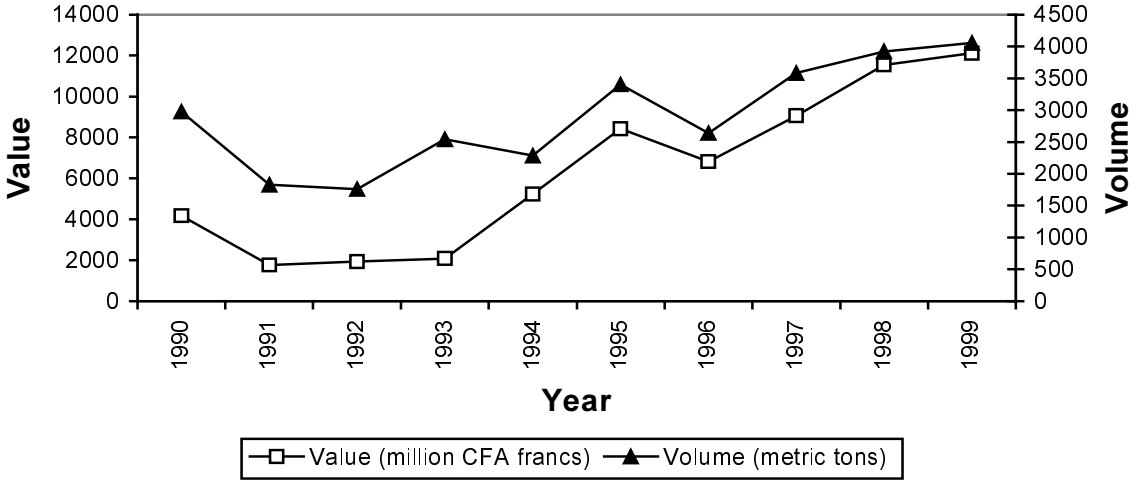
All of the pesticides used in the country are imported from the world market. There is a small amount of pesticide products which are domestically formulated on the basis of imported active ingredients. In the following chapter, the growth of the pesticide market is analyzed based on data covering external trade, local production, and distribution by the government and parastatal development agencies.

5.1 Pesticide imports

The volume of pesticide imports has seen a steady increase since 1991, going from 1,800 tons to more than 4,000 tons in 1999. The import value grew from 1.8 billion CFA francs in 1991 to 12.1 billion CFA francs in 1999. However, part of this value increase was due to the devaluation of the CFA franc in 1994. Pesticide imports represented 2.6% of total imports into Mali in 1999.

Total pesticide imports in Mali over the last 10 years are shown in Figure 5.1. These data only concern pesticide formulations, since it was not possible to obtain reliable data on active ingredients imported for local formulation.

Figure 5.1: Pesticide imports into Mali from 1990 to 1999



Source: DNSI (2000d)

Detailed statistics on the types of pesticides being imported into Mali are not available. Table 5.1 provides a breakdown by the standard classification used

in international trade, which, however, does not always seem to correspond with chemical or phytopharmaceutical pesticide classes.

Insecticides make up the majority of imported pesticides, amounting to 45% of the volume in 1999. Herbicides are becoming increasingly important, going from 11% of total imports in 1993 to 28% in 1999. However, there are large variations in the data base between the individual years.

Table 5.1: Value and quantity of pesticide imports into Mali, from 1990 to 1999

Pesticide class	Year									
	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
Value (million CFA francs)										
Household insecticides & mosquito coils	2758	1138	1083	395	229	136	539	629	392	39
Retail insecticides	116	108	72	81	655	1201	251	91	5008	1939
Other insecticides	283	0	145	914	2437	1437	1875	4946		2975
Fungicides	716	512	616	7	140	20	393	88	304	97
Herbicides, growth regulators & inhibitors	0	0	0	422	534	1515	3543	3237	4454	3903
Disinfectants	305	16	24	6	13	42	15	20	33	28
Other pesticides	0	0	0	254	1221	4075	196	40	1348	3135
Total	**4178**	**1774**	**1940**	**2079**	**5229**	**8426**	**6812**	**9051**	**11539**	**12116**
Quantity (metric tons)										
Household insecticides & mosquito coils	1648	1538	978	778	370	1681	644	824	494	873
Retail insecticides	62	60	80	310	324	110	181	61	1538	747
Other insecticides	867	0	321	932	962	442	537	1507	78	204
Fungicides	--	--	--	3	15	2	51	28	1475	134
Herbicides, growth regulators & inhibitors	362*	218*	359*	282	155	459	1158	1124	--	1132
Disinfectants	37	12	22	8	9	12	10	20	31	18
Other pesticides	--	--	--	228	450	697	57	16	305	947
Total	**2976**	**1828**	**1760**	**2541**	**2285**	**3403**	**2638**	**3580**	**3921**	**4055**

* for these years, the class “herbicides” includes fungicides as well.

Source: DNSI (2000d)

Mali procures its pesticides from a large number of different countries (28 in 1999). The major suppliers (by value) are France, Senegal, Ivory Coast,

United Kingdom and India (see Table A-5.1 in annex). Noteworthy is the increasing importance of Senegal at the expense of Côte d'Ivoire. Also, suppliers in "other countries" grew in market share, most of which are from South-East Asia. The new UEMOA harmonized import tax system may further favor the import from UEMOA member states.

5.2 Pesticide production

Pesticide production in Mali is limited to the formulation of commercial products; no local production of active ingredients exists. Two companies produce the bulk of locally manufactured pesticides: The Société Malienne de Produits Chimiques (SMPC) and the Société de Fabrication de Produits Insecticides au Mali (PRODIMAL). Smaller quantities of disinfectants are made by two other companies. Furthermore, a number of rather small local formulators of domestic pesticides are active in the country.

Table 5.2: Quantities of pesticides formulated in Mali by SMPC and PRODIMAL

Company	Year								
	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
SMPC									
Powder formulations (tons)	341	266	184	171	34	43	6	0	0
Liquid formulations (x1000 L)	2508	1020	896	628	312	409	456	508	500
PRODIMAL									
Aerosol cans (tons)									850
Mosquito coils (tons)									150

Source: SMPC statistics, DGRC (1999)

Production statistics could only be obtained from SMPC and PRODIMAL; while for the small local formulators no statistics seem to exist at all. Table 5.2 shows pesticide production by SMPC since 1990, and by PRODIMAL for 1999. The latter company produced about 1000 tons of household pesticides in 1999, mostly aerosol cans. SMPC mainly formulates cotton pesticides, and is partly state owned. While still an important producer in the early nineties, formulating about 3,000 tons of pesticides, the company now formulates only about 500 tons of pesticides per year. This reduction can be partly explained by the introduction of more concentrated EC formulations for cotton, which occurred in the mid-nineties.

5.3 Pesticide export from Mali

The export by Malian pesticide manufacturers or suppliers is fairly limited, and highly variable from year to year (Table 5.3). It amounted to a value of 160 million CFA francs in 1998. Most pesticides are exported to neighboring countries.

Table 5.3: Pesticide exports from Mali (in million CFA francs), from 1994 to 1998

Class of pesticide	Year					Destination
	94	95	96	97	98	
Household pesticides & mosquito coils	-	13	-	20	157	Indonesia, Burkina Faso, Guinea
Retail insecticides	-	-	-	-	3	Burkina Faso
Other insecticides	91	-	-	4	-	Niger, Senegal, Burkina Faso, Guinea
Herbicides, growth regulators & inhibitors	9	-	16	-	-	Ivory Coast
Disinfectants	-	-	-	0.2	-	Senegal
Total	100	13	16	24	160	

Sources: DNSI (2000d); DGD (1998)

5.4 The pesticide market in Mali

The volume of the pesticide market in Mali is estimated, based on the values of imports and local production of which exports are deducted. Data on the values of pesticide imports supplied by the Customs Directorate cover all official imports based on CIF values. Pesticide exports are also based on data provided by the Customs Directorate. For local production, only volumes were available. Therefore, average Malian sales prices were applied, and the estimate of the value of local production is expected to be fairly correct.

The results of these estimates are given in Table 5.5. The total pesticide market in Mali is estimated to be at least 17 billion CFA francs in 1998. If one presumes that the trend in production for PRODIMAL (for which available data cover only one year) has been similar to the general market trend, the value of the pesticide market in Mali has on average increased with 19% per year, between 1994 and 1998.

Table 5.4: Development of the value of the pesticide market in Mali (in million CFA francs) from 1994 to 1998

	Year				
	94	**95**	**96**	**97**	**98**
Imports	5 229	8 426	6 812	9 051	11 539
Exports	100	13	16	24	160
Production SPMC [1]	1 692	584	1 476	1 619	1 778
Production PRODIMAL [2]	-- [3]	--	--	--	3 775
National market					
without PRODIMAL	**6 821**	**8 997**	**8 272**	**10 646**	**13 157**
with PRODIMAL	**--**	**--**	**--**	**--**	**16 932**

[1] based on pesticide prices applied by CMDT; [2] based on average retail prices for household pesticides in Mali: coils=2500 CFA/kg, aerosols=4000 CFA/kg); [3] -- : data not available

Similarly, the volume of the pesticide market in Mali is given in Table 5.5. All data are as reported by the different sources. Import volumes are an underestimate of reality, since illegal imports are not registered. Similarly, as explained earlier, only the two major national formulators are included in the production estimate. Total pesticide production in Mali is likely to be higher.

Table 5.5: Development of the volume of the pesticide market in Mali (in metric tons) from 1994 to 1998.

	Year				
	94	**95**	**96**	**97**	**98**
Imports	2285	3403	2638	3580	3921
Exports [1]	40	5	6	10	64
Production SPMC	799	346	452	456	508
Production PRODIMAL	--	--	--	--	1000
National market					
without PRODIMAL	3 044	3 745	3 084	4 026	4 365
with PRODIMAL	-- [2]	--	--	--	5 365

[1] based on an average export value of 2500 CFA francs/kg or L ; [2] -- : data not available

The total volume of formulated pesticides available in Mali in 1998 was at least 5,400 tons.[4] As discussed above, this is certainly an underestimate of reality. Using a similar assumption about PRODIMAL production trends as above, the availability of pesticides in Mali increased with on average 11% between 1994 and 1998.

5.5 Pesticide distribution channels in Mali

There are three distribution channels for pesticides, i.e. distribution by private sector, distribution by parastatal development organizations, and the non-commercial channel (see Figure 5.2).

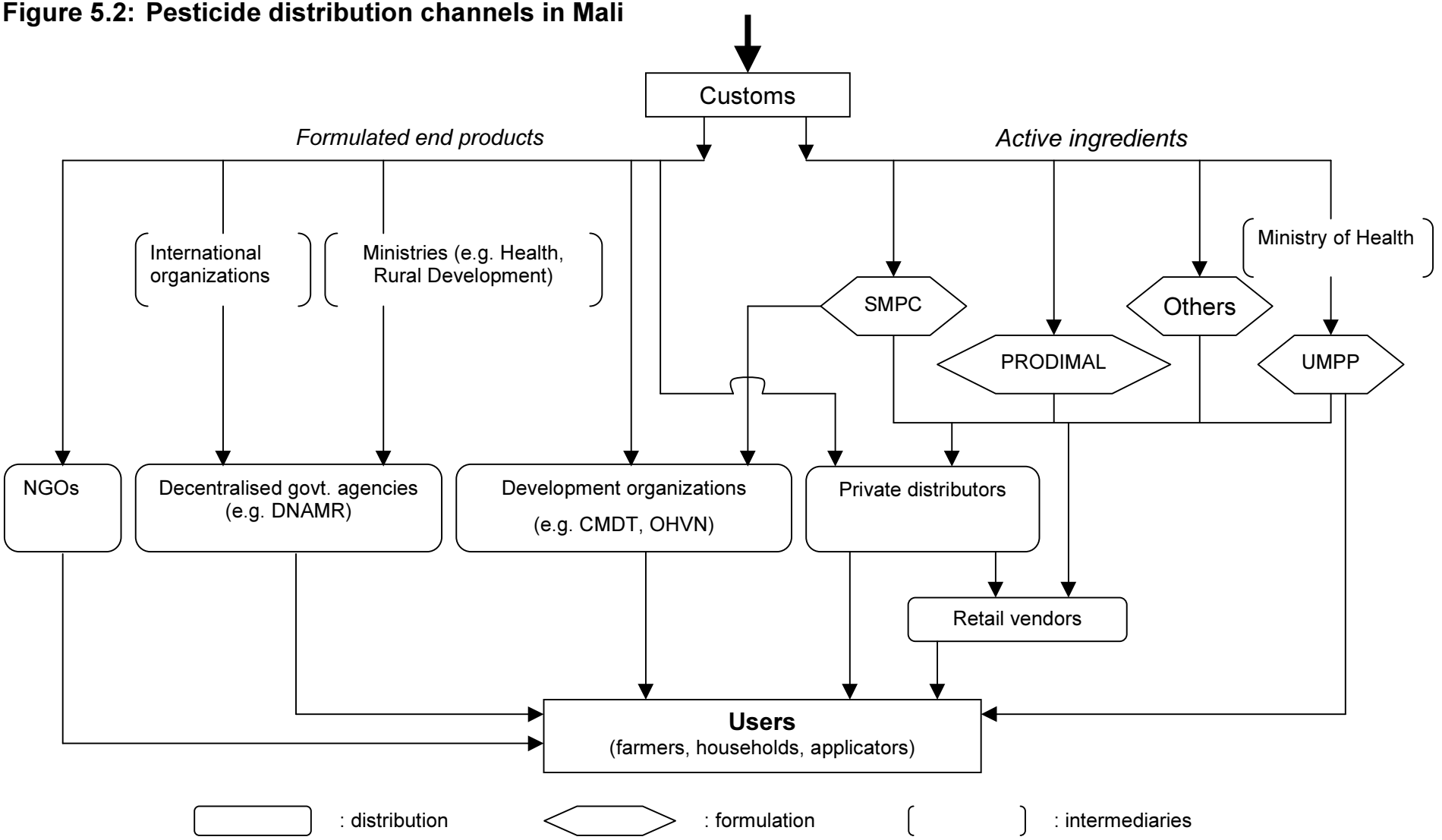
The commercial sector is represented by a number of large importers and distributors, often representing multinational agrochemical companies. They include SIPAMA (representing Novartis and Sochim Côte d'Ivoire), RECOMA (representing Marubeni), MPC (representing Calliope), Partenaire Agricole (representing Aventis) and Asteria (representing Dupont de Nemours). In addition, about 40 smaller retail distributors have been inventoried in the 6 major cities of Mali (DGRC, 1999). Many of the latter do not yet have official license.

The distribution channel passing by the agricultural development organizations is different from the private sector activities, in the sense that pesticides are procured centrally and sales prices to farmers are fixed at a uniform level for the whole country. More than 80% of pesticides in Mali pass by these channels (CMDT and OHVN being the two largest development organizations involved).

The non-commercial circuit consists of pesticides which are distributed free of charge to farmers or for public health programs. Sometimes these are supplied by NGOs but in some cases also by the Government (e.g. for locust control).

[4] For exports only values were available. The volume was estimated based on an estimated export price per unit of pesticide. This estimate is a best educated guess, and cannot be verified at present. However, given the limited importance of pesticide exports from Mali, this lack of precision will not influence the total estimate greatly.

Figure 5.2: Pesticide distribution channels in Mali



The only detailed information about the volume of the distribution channel is available for the pesticides supplied through the KR2 program, which are sold by the Ministry of Rural Development (Table 5.6). The market share of those pesticides is limited. The remark made earlier that these pesticides are relatively expensive is confirmed by Table 5.6, with their share in the total market value being very much higher than their volume would suggest.[5]

Table 5.6: Pesticide imports into Mali in the framework of the KR2 program, by quantity (metric tons) and value (million CFA francs)

	Year				
	94	**95**	**96**	**97**	**98**
Quantity	123	3	48	11	15
as % of total market [1]	*4.0%*	*0.1%*	*1.6%*	*0.3%*	*0.3%*
Value	607	82	555	335	456
as % of total market	*8.9%*	*0.9%*	*6.7%*	*3.1%*	*3.5%*

[1] market as estimated in Tables 5.5 and 5.6 (without PRODIMAL)

Source: DGRC (1999)

5.6 Pesticide use in the agricultural sector

The agricultural sector accounts for the largest fraction of pesticides used in Mali. Actual pesticide use statistics do not exist, but the yearly amount of pesticides distributed at farmer level could be obtained for a number of development organizations or government agencies. Here, it is considered to be used in the same year. Total pesticide use over the last decade is given in Table 5.7. It represents pesticide use by about 20 development organizations and agencies.

Included in these statistics are (almost) all pesticides used in the production of cotton, cereals, sugar cane and tobacco. Most of these quantities pass through (directly or indirectly) government controlled distribution channels. Statistics were not available for use by farmers who mainly obtain pesticides through the commercial outlets, such as many fruit and vegetable producers. Data provided in Table 5.7 is thus an underestimate of real use in Mali.

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[5] The findings of chapter 3.5 that these pesticides are relatively expensive are confirmed by Table 5.6. The share of the value of KR2 pesticides in the total market value is far higher than their volume would suggest.

Table 5.7: Quantities of pesticides (formulations) used in the agricultural sector from 1990/91 to 1998/99

Type of pesticide	Year								
	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
Fungicides (x1000 kg)	3	5	4	11	52	0	55	45	53
Insecticides (tons. eq.) [1]	3168	2850	2982	1979	1812	1332	1440	3803	4070
Herbicides (x1000 L)	160	196	175	269	212	206	246	669	683
Rodenticides (x 1000 kg)	0.15	0.04	4.95	2	0.05	0	0	0	0
Total pesticides (tons. eq.) [1]	3350	3051	3166	2261	2075	1538	3120	4517	4806

[1] metric tons equivalent: 1 ton = 1000 kg or 1000 L

Sources: DNA (1992 à 1996); DNAMR (1999, 2000)

Three actors represent more than 90% of total pesticide use: CMDT, OHVN and DNAMR (formerly SNPV) (Table 5.8). Most pesticides obtained by CMDT and OHVN are used in cotton (see also chapter 3.2). Pesticides distributed by DNAMR are mostly used for migratory pest control (locusts, grasshoppers and granivorous birds) and by subsistence farmers on cereals and other crops for a variety of pests.

Table 5.8: Agricultural pesticide use by the three major actors in Mali, from 1990 to 1998.

Structures	Year								
	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
CMDT (tons eq.) [1]	2273	2314	2641	1895	1822	1213	1687	2333	2918
OHVN (tons eq.)	135	129	149	109	145	180	929	1234	1597
DNAMR (tons eq.)	808	521	311	203	31	77	-- [2]	--	--
Total (tons eq.)	3216	2964	3101	2207	1998	1469	2616	3567	4515
% of total use	96	97	98	98	96	96	84	79	94
Rest (%)	4	3	2	2	4	4	16	21	6

[1] metric tons equivalent : 1 ton = 1000 kg or 1000 L ; [2] -- : no data available

Source: CMDT (2000a), DNAMR (2000), OHVN (2000)

During the last three years of the assessment, pesticide use by OHVN has greatly increased. This was mainly due to the recent extension of the cotton area managed by OHVN. Statistics for pesticide use by DNAMR were only available for the period until 1996. However, the reduction in use observed earlier in the decade has probably continued during this period. DNAMR obtains most of its pesticides from donors (e.g. the KR2 program), often for emergency pest control.

5.7 Pesticide use in the public health sector

Until 1993, the Ministry of Health was responsible for the execution of public health pest control in Mali (mainly mosquito and black fly control). More recently, these tasks have been transferred to local communities and the private sector, with the Hygiene Service ensuring training and technical assistance.

In the period 1990 to 1992, about 630 tons per year were imported for public health pest control (DNS, 1993). This was, at the time, approximately 19% of pesticide use in the agricultural sector. Due to the above mentioned decentralization, no statistics are available anymore after 1992. The Ministry of Health does not collect such data at local community level. It is therefore impossible to estimate pesticide use for public health. However, the figures from the early nineties suggest that this may still be considerable.

Apart from the data on import and production of household pesticides presented in section 5.1 and 5.2, no detailed use statistics are available at all in Mali.

5.8 Pesticide use for veterinary pest control

No statistics are collected, on a regular basis, on pesticides used for veterinary purposes. An isolated study, covering the period 1995 to 1997, estimated that about 78 tons of pesticides were used annually for veterinary pest control in Mali, with a total value of 220 million CFA francs (Diallo, 1997).

With the ongoing decentralization of the government's veterinary services, and the increased private sector activities in this field, use statistics are currently impossible to obtain.

5.9 Summary

There is a lack of comprehensive statistics about pesticide imports, production and distribution in Mali which limits the full understanding of the importance of pesticide use in the country. Import statistics neither allow for a differentiation according to environmental and health hazard categories nor do they distinguish between formulated products and active ingredients. However, this information is necessary to determine future government policies on agricultural productivity enhancement, health risk mitigation, and environmental protection.

Based on the available data, the pesticide market is estimated to have reached a volume of at least 5,400 tons formulated product in 1998, with a value of about 17 billion CFA francs (about US $ 25 million). The market increased on average at an annual rate of 11 % by volume, or 19 % by value, respectively, from 1994 to 1998. While the growth can be partly explained by an expansion of cotton production to new areas, the increase of pesticide use nevertheless exceeded agricultural growth (1.5 % in the same period) by far.

About 84 % of the total quantity is used in the agricultural sector. Insecticides are the dominant group of pesticides. More than 90 % of this quantity is distributed by the parastatal cotton development agencies and the Ministry of Agriculture.

In the 1990s, the relative importance of pesticides in the Malian economy has been growing. Whether this development is accompanied by increased agricultural productivity, needs to be determined by detailed economic research. Currently, pesticide use stands at 1.9 % of total GDP. Agricultural pesticide use is 4.5 % of agricultural GDP. Both indicators suggest an already high dependence on chemical pesticides[6].

[6] In Cote d'Ivoire, the same indicators are 0.3 % for total GDP, and 1.2 % for agricultural GDP (1995, see Fleischer *et al.* 1998). Mali itself spends only slightly higher shares of its GDP for education and health care (each 2.2 %, UNDP 2000).

6 Analysis of pesticide use in the main crops

In this chapter, we will further analyze the development of crop loss and pesticide use over the last decade in the main crops, notably cotton, rice and other cereals. Data were obtained from the planning unit of the agricultural ministry. They basically refer to statistics of the parastatal agencies, but generally do not include crops and areas which are not under the mandate of those agencies. No comprehensive data are currently available about pesticide use in fruit and vegetable production because of the lack of government extension and development agencies in those areas.

6.1 Cotton

6.1.1 Crop loss

Cotton is generally referred to as a crop which is sensitive to pests and diseases. The world-wide crop loss evaluation by Oerke *et al*. (1999) provides average figures for Africa, over the period 1975-1990.[7] According to these figures, average losses at yield levels ranging from 600 to 1300 kg/ha are 85 % of the potential yield when no crop protection measures are done. Taking the current level of pesticide use into account, still 49 % of the yield is lost. Loss from insect and mite pest damage including viral diseases transmitted by them, is most important.

Unfortunately, no comprehensive analysis of crop loss in cotton exists for Mali. This is in spite of the importance of the crop and the long-standing research carried out in the country. Only isolated studies are available, mostly carried out as part of pesticide efficacy trials.

Delattre and Gall (1982, cited in Oerke *et al*., 1999) estimate average potential losses of 35% due to insect pests, for the period 1969 *to* 1981. Similar losses due to pests were reported by Cadou (cited in Michel, 1999). More recently, in the period 1993 to 1998, Michel (1999) carried out crop loss assessments in Mali and reported average potential losses of about 20 to 30 % due to pests.

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[7] The study of Oerke *et al.* (1999) is the most comprehensive evaluation of crop loss research results and pesticide efficacy trials. However, the methodology of the study has been criticized for exaggerating crop loss. Furthermore, the methodology ignores economic considerations. Conclusions on crop loss estimates therefor should be made with caution as the results tend to overestimate the contribution of crop protection to value–added in agriculture. Yudelman *et al.* (1998) state that, despite the availability of only casual observations of actual field-level crop loss, estimates tend to become entrenched. Estimated losses from pests in a number of African countries have been “fixed” at about 30 % with little scientific validity for several decades.

However, losses were variable according to year and location, and ranged from 11 to 82%.

All these estimates are much less than the overall potential loss figures documented for Africa in general by Oerke *et al.* (1999), which average from 60 to 65%. Cotton production in Mali is indeed generally seen as being affected less by insect and mite pests than in many other parts of Africa.

Pesticide use

The development of pesticide use in cotton over the last decade is given in Table 6.1. The data generally refer to the amount distributed to village associations in a given years, which is however considered to be close to actual pesticide use in most years. Cotton pesticides represent, on average, about 80 % of total agricultural pesticide use in Mali. About 95 % of total pesticide use in cotton are insecticides.

Table 6.1: Pesticide distribution for cotton in Mali, from 1990 to 1999

Type of pesticide	Growing season								
	90/91	**91/92**	**92/93**	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**
Insecticides (x1000 L)	2246	2244	2619	1738	1719	1256	2347	3046	3787
Herbicides (x 1000 L)	68,5	99,1	71,7	43,9	56,6	96,6	111	259	358
Fungicides (tons)	0.09	2.1	--	3.3	49.9	--	24.5	31	45.2
Total (tons equivalent)	2314	2346	2690	1785	1826	1353	2482	3336	4190
% of total agricultural pesticide use	*69*	*77*	*85*	*79*	*88*	*88*	*80*	*74*	*87*

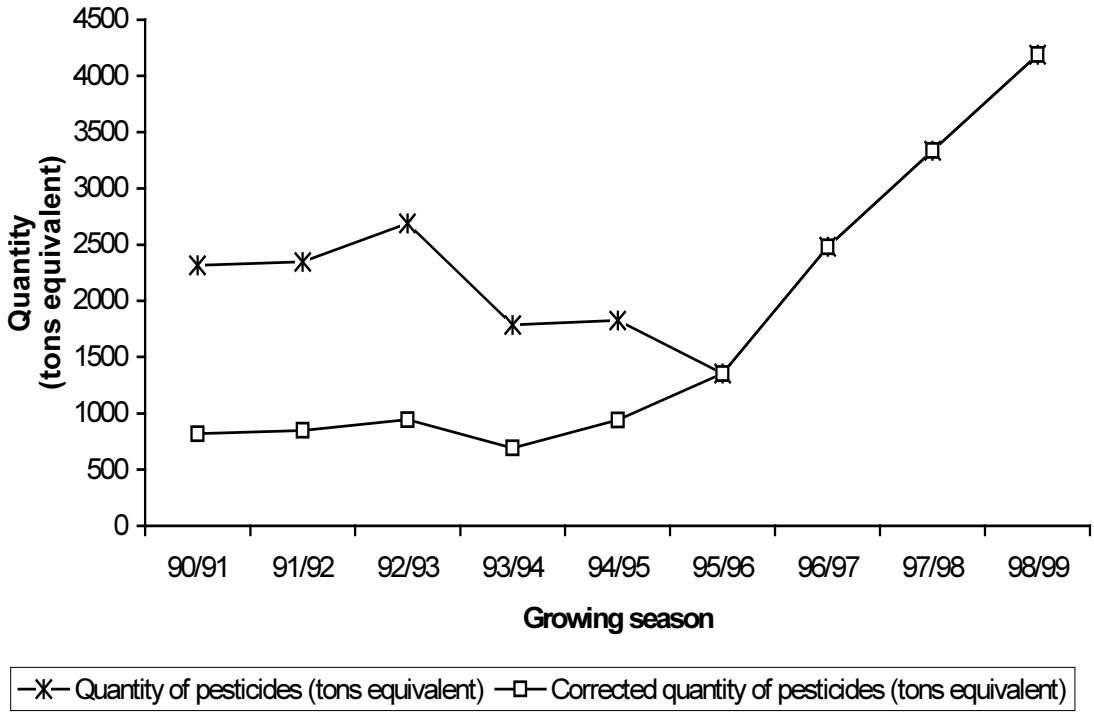
Sources: DNA (1992 to 1996); DNAMR (1999, 2000); CMDT (2000a); OHVN (2000)

Pesticide use has effectively increased during the entire period. The reduction in insecticide use seen from 1993 to 1995 is to a large extent due to a change in the type of pesticide formulation. Until 1993, insecticides were all applied as ultra low volume (ULV) formulations at a rate of 3 liters of formulated product per hectare. Subsequently, the formulations were changed to emulsifiable concentrates (EC), which are applied at a rate of 1 liter of formulation per hectare. The rates of active ingredients per hectare did, however, not change, thus requiring EC formulations that are three times as concentrated as the ULV ones. The reduction seen in insecticide use in Table 6.1 as of 1993 is to a large extent due to this change in formulations and does not represent the real development in the use of active ingredients.

In Figure 6.1, we corrected pesticide use in cotton for this change in formulation, expressing all insecticides in “EC formulation equivalents”. This

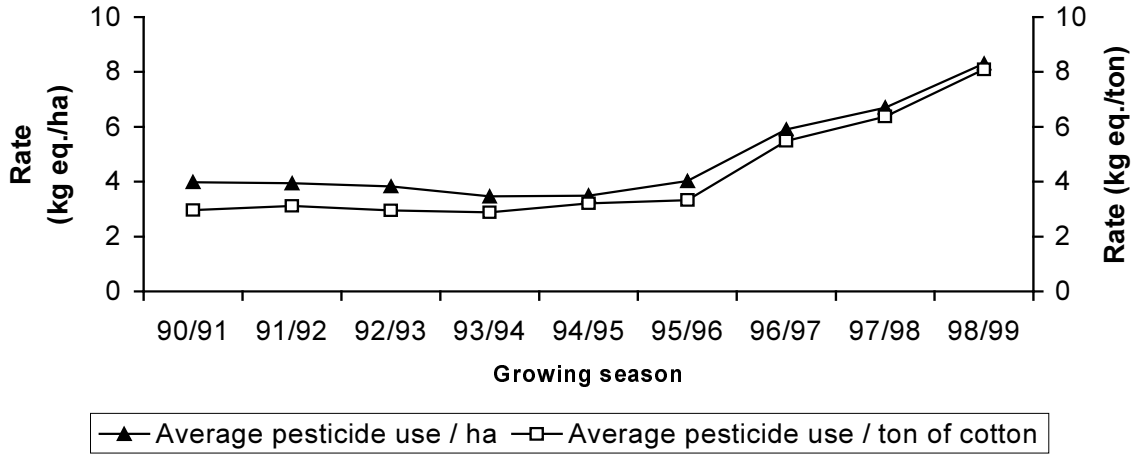
graph shows, contrary to Table 6.1, that pesticide use remains relatively stable until 1994, after which it increased every year.

Figure 6.1: Gross total pesticide use (ULV et EC) in cotton, and its corrected use (EC equivalents) from 1990 to 1998.



Not only has the total quantity of pesticides in cotton increased, so has the intensity of their use. Figure 6.2 shows the amount of pesticides needed per hectare and per ton of cotton produced, between 1990 and 1998. After a period of relative stability until 1995 (approximately 3.6 liters/ha), pesticide distribution (and subsequent use) increased dramatically beginning in 1996, attaining on average almost 8 liters/ha in 1998.

Figure 6.2: Development of the intensity of pesticide use (EC equivalent volumes) in cotton production, from 1990 to 1998.



Source: Tables 2.5 and 6.1

Figure 6.3 shows that the increase in the intensity of pesticide use is entirely due to the growth in insecticides. Average intensity of herbicide and fungicide use has remained relatively stable.

It is not entirely clear why insecticide use has intensified so much over the last 4 years. This may be due to the recent appearance of new pests, such as white fly (*Bemisia tabaci*). More likely is that it is the effect of increasing resistance against pyrethroids in the population of the American boll worm (*Helicoverpa armigera)*. Since the 1996/97 growing season, several West-African countries have started introducing resistance management measures, which coincides exactly with the increase in pesticide use intensity observed.

In spite of the increased use of insecticides in cotton, the fraction of gross revenues which the farmer has to spend on pesticides has remained relatively constant (Table 6.2). This is partly due to the increase in cotton prices but also due to the stability of pesticide prices since the devaluation (see chapter 1).

Figure 6.3: Development of the use intensity of various types of pesticides on cotton from 1990 to 1998, in Mali (insecticide use before 1995 was corrected as EC-equivalents)

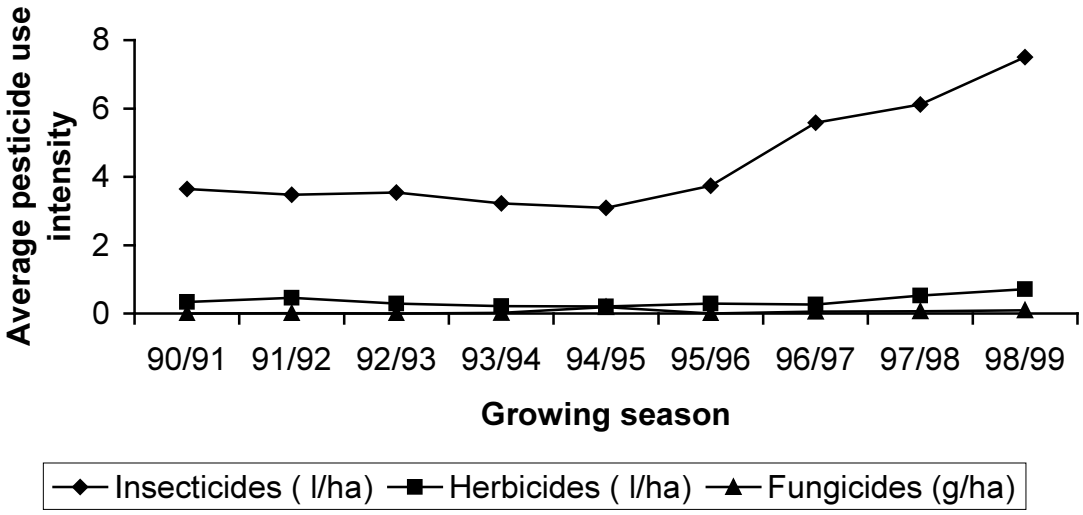


Table 6.2: Development of the gross farmer revenues and pesticide costs in cotton production in Mali, from 1990/91 to 1998/99.

	Growing season								
	90/91	**91/92**	**92/93**	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**
Total gross cotton revenues[1] (billion CFA francs)	25.7	25.9	27.2	23.5	38.1	63.0	70.1	88.9	95.7
Total pesticide costs[1] (billion CFA francs)	3.13	3.23	3.63	2.59	5.30	5.40	8.56	11.62	13.85
Pesticide costs per ha (x1000 CFA francs/ha)	15	15	15	13	20	16	20	23	27
Gross revenue per hectare (x1000 CFA francs/ha)	125	121	111	117	142	188	167	179	191
Ratio of pesticide costs / gross revenues	0.12	0.12	0.14	0.11	0.14	0.09	0.12	0.13	0.14

[1] All values are at farmer level

Source: based on tables 2.5 and 6.1

6.1.2 Alternatives to intensive pesticide use

Since a number of years, the CMDT has been experimenting with pesticide application based on action thresholds, the so-called “lutte étagée ciblée” (LEC). Compared with the calendar treatment carried out on most of the cotton area, the LEC method may reduce pesticide use by 45%. It is presently applied on only 4% of the total area grown with cotton, but CMDT intends to increase this fraction in the coming years. The fact that the LEC system can result in a considerable reduction in pesticide use suggests that important opportunities for improved pest management in cotton still exist in Mali. However, the LEC method can potentially increase insect pest resistance problems as emphasis is laid on reducing the dosage per treatment as opposed to decreasing the number of sprays.

A pilot initiative for production of organic cotton started in 1999 in the southern part of Mali with support of Swiss development aid (Helvetas-Mali, 2000).

6.2 Rice

Development of rice production is promoted by various development agencies of which the Office du Niger is the most important. These agencies are engaged in the management of irrigated parameters in the lowlands of the river Niger and its contributing rivers.

6.2.1 Crop loss

Africa-wide data on crop losses in rice are available as compiled by Oerke *et al*. (1999). The data are split according to yields. Yield levels of more than 3,500 kg/ha are obtained in Mali in certain irrigated areas, while levels between 1,800 and 3,500 kg/ha are obtained more widely.

Total potential losses due to all factors average 76 to 80% in Africa; actual losses range from 35 to 52%. Weeds are the most important crop loss factor. Detailed research results for Mali are not yet available.

6.2.2 Pesticide use

Given the potential importance of weeds as a yield reduction factor, it is no surprise that herbicides constitute the large majority of pesticides used in rice (Table 6.3). However, most weed control in Mali is still mechanic, either by weeding or water level control in irrigated rice. Only recently herbicides have become more important as a weed management tool. Small quantities of rodenticides and insecticides are also used, the latter mostly in seed beds.

Table 6.3: Pesticide use in rice in Mali, from 1990 to 1998.

Type of pesticide	*Growing season*								
	90/91	**91/92**	**92/93**	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**
Fungicides (kg)	-- [1]	20	--	--	--	--	--	--	--
Insecticides (kg or L)	--	80	--	--	14	--	--	--	--
Herbicides (L)	41	28	24	86211	12687	5826	9086	16901	27543
Rodenticides (kg)	145	--	--	--	--	--	--	--	--
Total pesticide (tons equivalent)	0.19	0.13	0.02	86.2	12.7	5.83	9.09	16.9	27.5
% of total agricult. pesticide use	0.006	0.004	0.001	3.8	0.6	0.4	0.3	0.3	0.6

[1] -- = no data

Sources: DNA (1992 to 1996); DNAMR (1999, 2000)

Unlike CMDT and OHVN, the main rice development organizations (e.g. Office du Niger, perimeters of Selingué and Baguineda) do not sell pesticides to their rice farmers. Most pesticides are obtained through private distributors and DNAMR.

Average rice yields have grown steadily during the last decade. However, it is unclear to what extent herbicide use has contributed to this growth. Apart from the 1993/94 season, herbicide use has only started to intensify after 1996, and remains even then at very low levels.

Since no statistics exist on private pesticide distribution, the quantities in Table 7.5 are certainly an underestimate of reality. However, in spite of this, pesticide use in rice represents only a very small fraction of total agricultural use, hardly ever surpassing 0.5%.

6.2.3 Alternatives

Since 1996, several small integrated pest management projects have been initiated in rice in Mali (Nacro, 2001). Since pesticide use is low, the main goal of these projects was not to reduce agrochemical inputs but to improve pest management practices in such a way as to avoid future increases in pesticides use while maintaining or increasing rice yields.

6.3 Other cereals

6.3.1 Crop loss

The most important cereals in Mali, other than rice, are millet, sorghum and maize. Of these, Africa-wide loss estimates only exist for maize (Oerke *et al*., 1999). Average potential losses range from 68 to 76%, weeds being the most important potential loss factor. However, actual losses due to weeds are much less, because hand weeding is possible for most if not all maize farmers. Real losses due to insects are more important, probably because only limited insect pest management tools are available and/or being used by farmers in Africa.

A large number of studies have been carried out in Mali over the last decades to investigate crop losses in millet, sorghum and, to a lesser extent, maize. However, there do not seem to be comprehensive national reviews of such losses for any of these crops.

Typically, losses are highly variable, depending largely on time and location. Table 6.4 provides an example of crop loss assessments carried out in millet over several years and on different locations in western Mali. In a year with high grasshopper densities (1990), crop losses ranging from 6 to 85% were observed. On the other hand, in a year with light infestations and good rainfall (1991), losses never surpassed 10%. For such reasons, the value of average loss figures is only limited. It would be much more useful to compile region or nation-wide crop loss evaluations which quantify variability rather than average values. Unfortunately, as was noted above, in spite of a large amount of data having been collected, no such compilation appears yet to have been made.

Table 6.4: Millet yield loss due to grasshopper damage, in Mali.

Year	Level of losses	% loss	Actual yield (kg/ha)	Actual losses (kg/ha)
1990 [1]	Minimum	6	1231	75
	Maximum	85	29	159
	Average	17	556	113
1991	Minimum	1.2	752	9
	Maximum	10	455	52
	Average	4	635	29

[1] evaluation based on the data of 29 fields (1990) and of 30 fields (1991) in 9 different villages south of Nara, Mali

Source: Coop and Croft (1994)

6.3.2 Pesticide use

The trends in pesticide use in cereals other than rice is given in Table 6.5. After still representing about 25% of total agricultural pesticide use in the early nineties, it has dropped to approximately 12% over the last few years.

Table 6.5: Pesticide use in cereals other than rice, from 1990/91 to 1998/99.

Type	Growing season								
	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
Fungicides (tons)	3	3	4	8	2	0	31	0	7
Insecticides (tons eq.)	938	605	303	240	91	77	205	313	283
Herbicides (x1000 L)	0.4	107	172	97	104	116	122	328	293
Rodenticides (kg) [1]	8	42	0	2000	50	0	0	0	0
Total pesticides (tons equivalent)	941	715	480	346	197	193	358	642	584
% of total agricultural pesticide use	28	23	15	15	9	13	11	14	12

[1] -- = no comprehensive data

Sources: DNA (1992 to 1996); DNAMR (1999, 2000)

Insecticide use has especially decreased, which is probably linked to a reduction in availability of the products provided by DNAMR. A high level of insecticide use was still made available by donors for locust and grasshopper control in the early nineties, which is not the case any more in recent years. On the other hand, herbicide use has increased considerably, mostly in maize production.

Figure 6.4 shows that there seems to be only a loose relationship between average cereal yields and pesticide use. However, at this level of aggregation, meaningful evaluations are not possible. No further analysis was carried out on the data since pesticide use could not be satisfactorily linked to the production data of individual cereals.

6.3.3 Alternatives

There are presently no major projects or programs with the aim to to improve pest management or to limit pesticide use in cereals other than rice. However, a comparatively large amount of research results carried out in Mali in the eighties (CILSS regional IPM program) and nineties (British millet pest management program) are available, together with regional work done within the framework of the research networks ROCAFREMI and ROCARS. Few, if

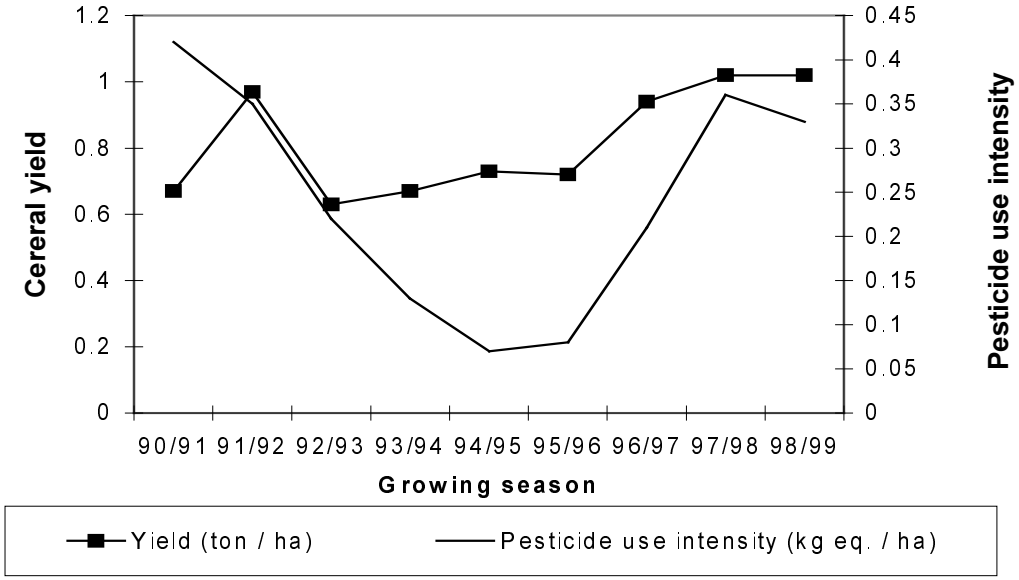
any, in-depth evaluations have been carried out to date to see to what extent such results could be applied to present cereal production in Mali.

6.4 Other areas of pesticide use

Horticultural crops are grown around the cities, in irrigation perimeters and in the southern parts of the country. Vegetables and fruits complement the diet of subsistence farmers and are increasingly produced for sale at domestic and export markets. The most important crops are mangoes, French beans, tomatoes and leaf vegetables.

Although detailed statistics are not available, there are frequent concerns that pesticide use in horticultural production is done in an anarchic manner. Growers seem to have little or no knowledge about pest identification and risks associated with pesticide application. High pesticide use intensity and misuse patterns pose potential health risks for applicators and consumers. Export opportunities are threatened by the presence of pesticide residues in food. This is especially the case for exports to the European Union after the onset of the revised Maximum Residue Limits (COLEACP, 2000). Few research has been done for alternatives to intensive pesticide use, e.g. through the USAID-funded IPM-CRSP program implemented by IER.

Figure 6.4: Development the average yields of cereals (except rice) and pesticide use intensity in Mali, from 1990 to 1998.



Since 1987, responsibility for locust control has been allocated to a specialized government service (SNPV) in the agricultural ministry. SNPV established regional branches which were active during the large locust outbreaks at the end of the 1980s. As locust migration is particularly linked to rainfall patterns, potential damage varies to a large degree. Joffe (1998) estimates that Mali could loose 1 % of its production in an outbreak year. While this potential production loss is negligible compared to other production risks, impacts can be large for local subsistence economies where market integration is weak.

The government spends annually an amount of US $ 225,000 for supervision of locust populations alone. Additionally, there are costs for pesticides, labor and other variable costs depending on control activities (Joffe, 1998).

6.5 Discussion

There is a limited amount of data available that allow the evaluation of pesticide use at individual crop level. The central distribution system for agricultural inputs which is managed by CMDT and OHVN for cotton growing areas allows a fairly comprehensive assessment of pesticide use trends in this crop. Cotton absorbs about 80 % of all pesticide use in the country. Over the last decade, cotton pesticide use has grown substantially due to area expansion and increased intensity. The latter must probably be attributed to the development of resistance of insect pests against pesticides and to emergence of secondary pests as experiences from other countries suggest (Schillhorn van Veen *et al.*, 1997, Ahmad *et al.*, 2001).

At this point, there are no economic studies available that compare different crop protection strategies. However, trends of increasing pesticide use in cotton which are accompanied by declining average yields suggest that the economic viability of pesticide use is definitely not improving, but rather deteriorating. This development threatens to hurt the competitiveness of Malian cotton production in the future.

Contrary to the development in cotton, pesticide use in rice and other cereals did not grow in the 1990s while yields and total production increased substantially. This suggests that other factors than pesticide use have been responsible for productivity enhancement.

7 Social costs of pesticide use

In this chapter, an attempt is made to assess the social costs related to pesticide use in Mali. Social costs of pesticides are comprised of private costs borne by the user, and external costs which have to be paid by others or the society as a whole (Pearce and Tinch, 1998).

In the following analysis, we distinguish three levels:

I. Direct costs at farm level. Those are all monetary and non-monetary expenses made by a farmer which are obviously related to the decision-making about pesticide use;

II. Indirect costs at farm level. Pesticide use causes indirect and hidden effects such as occupational health hazards and damage to beneficial insects. Those costs are borne by the farmer in the long run, but due to lack of information and awareness rarely taken into account.

III. External costs. Those costs are not borne by the farmer, but by other members of the society or the society as a whole. Examples are costs of health damage due to pesticide residues in food and environmental pollution.

Table 7.1 lists the areas that will be analyzed in this chapter.

Table 7.1: Assessment of direct and indirect costs of pesticide use in Mali

Type of costs	Direct	Indirect	
	Costs paid by the farmer	Hidden costs, borne by the farmer	External costs, borne by society
Pesticide supply	✓		✓[1]
Pesticide transport	✓		✓
Pesticide application (labor cost)	✓		✓
Application equipment	✓		✓[1]
Equipment for personal protection	✓		
Pesticide storage	✓		✓
Damage to human health		✓	✓
Pesticide and container disposal			✓
Pesticide residues in water		✓	✓
Pesticide residues in food		✓	✓
Pollinator reduction		✓	✓
Pest resistance development		✓	✓
Secondary pest development or pest resurgence		✓	✓
Soil fertility reduction		✓	
Loss of biodiversity		✓	✓
Environmental pollution during pesticide production			✓
Pesticide management and control costs			✓

[1] in the case of subsidies

7.1 Direct costs of pesticide use

Pesticide supply

In Mali most pesticides are purchased directly by the farmer and constitute direct costs. In the case of cotton, insecticides are supplied on credit by the parastatals CMDT and OHVN. Their price is currently subsidized, if one accounts for the difference between the farm gate price and full costs (see section 3.5). However, subsidies for insecticide use are likely to be recovered from the cotton farming community as a whole by means of reduced producer prices for cotton.

In the case of migratory bird and locust control, the government provides pesticides free of charge. However, expenses for control at the end of the 1990s have been only a small fraction of those made during the large desert locust outbreaks in the late 1980s.

A special case are pesticides provided through the KR2 program. Their use causes indirect costs for the society through the requirement to replenish the government counterpart fund (section 3.5). Society pays the complete pesticide bill in the case of bird and migratory locust control, which is carried out by the government.

Pesticide transport

The cost of pesticide transport is normally included in the farm-gate price of the pesticide, and thus paid by the farmer. In some cases, the government (and thus society) pays for transport. This is the case for pesticides which are used by or distributed through DNAMR, such as KR2 products.

Pesticide application

Most often in Mali, pesticide application is carried out by a member of the family of the farmer. Sometimes, an external applicator is hired. In both cases, costs are directly borne by the farmer. In the cotton growing area of Mali, the hiring of a pesticide applicator costs about 1250 CFA francs per day.

In the cases where pest control carried out by DNAMR (e.g. granivorous birds and locusts), pesticide application costs are paid by the government.

Pesticide application equipment

The costs of sprayers being used for cotton range from 25,000 to 39,500 CFA francs a piece. However, cheaper sprayers are available for other crops. Spare parts will also be needed on a regular basis. Assuming a working life of a sprayer of 5 years, depreciation would range from 5,000 to 7,900 CFA francs per year, spare parts not included.

Equipment for personal protection

A minimum of personal protective equipment is required if pesticides are to be applied with minimum risk to the applicator. Table 7.2 provides a list with the minimum recommended protective equipment according to the WHO for pesticides falling in hazard class II, which is representative of many pesticides used in cotton, cereals and vegetables in Mali. Cost estimates are based on Bamako market prices.

Average yearly cost of this personal protective equipment would range from 6,100 to 12,250 CFA francs per year. In reality, very few farmers use protective equipment in Mali, in part because they cannot afford it.

Table 7.2: Costs of personal protective equipment for pesticide application as available on the market in Bamako, Mali.

Type	Price (CFA francs per unit)	Optimal duration of use [1]
1. Overalls or traditional working clothes	8,500 – 17,500	4 years
2. Gloves (PVC, nitrile)	1,750 – 5,000	1 year
3. Closed shoes	5,000	4 years
4a. Dust mask (for dust formulations)	200	2 treatments
4b. Face shield (liquid formulations)	5,000	4 years
5. Cotton hat or cap	750	2 years
Annual depreciation for the complete set (1+2+3+4a or 4b+5)	6,100 – 12,250	

[1] if only used for pesticide application

Source: survey on Bamako market, 2000

Pesticide storage

Pesticide storage costs are primarily included in the price of the pesticide. Costs are therefore paid by the farmer. This is also the case for secondary storage, after purchasing, when the pesticide is kept on the farm, but also when common storage is ensured by the Village Associations to which farmers pay contributions. Pesticides used by or distributed through DNAMR are stored at the expenses of the government.

Overall costs at the farm level

As an example, the yearly direct costs supported by a cotton farmer in Mali are given in Table 7.3. It is assumed that the farmer treats 5 times with an insecticide during a growing season. The total costs range from 30,000 to 40,000 CFA francs per hectare per year, presuming a farmer grows a 1 ha field of cotton. In reality, only few farmers will have bought personal protective equipment. In such a case the total costs are reduced by 20 to 30%. In the latter case it can be expected, however, that the human health costs would be higher than for properly protected farmers (see below).

Table 7.3: Total direct pesticide costs for a cotton farmer in Mali, applying insecticides 5 times during a growing season to a one ha field.

Type	Yearly costs (CFA francs)	Remarks
Insecticide (5 liters)	17,000	
Transport	0	Included in pesticide price
Application costs (5x3 hours)	2,400	Either applicator hire or opportunity cost
Sprayer	5,000 – 7,900	
Protective equipment	6,100 – 12,250	
Storage	0	Included in pesticide price
Total	30,500 – 39,550	

7.2 Indirect costs of pesticide use

Human health costs

Pesticide use is never completely without risk for the health of the farmer, applicator or consumer. Pesticide exposure may occur during work (occupational exposure), via the environment (e.g. by spray drift) or through consumption (e.g. of contaminated food or water). Pesticide applicators and farmers are generally most at risk of intoxication.

The effects of acute pesticide poisoning range from light (headaches, nausea) to heavy (permanent disability, death). Clearly the economic impact of such poisoning varies as well. It would be measured differently, depending on the gravity of the case:

- Very light intoxication: little economic impact ;
- Light intoxication: purchase of medication for symptomatic treatment, reduction of work efficacy;
- Moderate intoxication: purchase of more specific medication (e.g. antidotes), non-productive rest days, loss of productivity or necessity to hire day labor;
- Severe intoxication: purchase of specific medication; hospitalization, non-productive recuperation period, loss of productivity or necessity to hire day labor;
- Very severe intoxication: loss of human life.

Chronic poisoning due to pesticides is generally less specific and it is more difficult to establish causal links. Effects may include neuropsychiatric disease, cancer, reduction of fertility, effects on reproduction or on the unborn embryo.

Poisoning cases in Mali

No comprehensive statistics exist in Mali on (pesticide) poisoning, nor have their effects ever been quantified economically (Djiba, 1997). As a result, we can only attempt to provide estimates. These are either based on specific case studies from Mali, or on more general studies carried our elsewhere in the world. In both cases extrapolation to the general Malian situation is required.

Table 7.4: Estimate of the costs to human health of pesticide use in Mali

Type of cost	Number of people (or man-days) affected per year			Unit cost per person (CFA francs)	Total yearly cost for Mali (millions of CFA francs)		
	estimate				**estimate**		
	min.	**average**	**max.**		**min.**	**average**	**max.**
1. Medical treatment [1] (persons)	0	32,800	110 200	1,120	0	36.7	123.4
2. Medical treatment/hospitalization (persons)	329	1,466	2,570	4,260	1.40	6.25	10.9
3. Replacement of labor (man-days)	54,000	207,300	251,000	1,250 [2]	67.5	259.1	313.8
4. Chronic loss of productivity (persons)	1,150	1,565	1,980	74,000	85.1	115.8	146.5
5. Loss of human life (persons)	6	69	210	2,205,000	13.2	152.1	463.1
Total					167.2	570	1,058

[1] figures corrected for hospitalizations and deaths; [2] cost per man-day

Source: see Table A 7.1 in the annex

The results of such an estimate are presented in Table 7.1 in the annex. Data are summarized in the first columns of Table 7.4. More details about the methodology applied are provided in Camara *et al*. (2001). The minimum and maximum values for some estimates cover a wide range (e.g. for the number of people needing basic medical treatment). Others are much closer, like the loss of productivity due to chronic intoxication or the replacement of labor. Confidence in the estimates is increased, however, by the fact that completely

different studies, sometimes carried out on different continents, often produced extrapolations for Mali which are of the same order of magnitude.

Costs of health effects in Mali

No standardized costs for health effects of poisoning in Mali could be obtained. The estimates given in the fifth column of Table 7.4 are based on actual average costs in rural Mali (for medication, hospitalization and replacement of labor). The costs of chronic loss of productivity and of human life are based on the agricultural GDP per habitant. Chronic loss of productivity was estimated to cost 50% of the annual agricultural GDP per habitant. Loss of life was economically quantified as the reduction of agricultural GDP per habitant during the mean economically active life in agriculture (set at 50 % of 30 years)[8].

Economic impact of pesticide intoxication in Mali

This results in the estimates of the cost of pesticide intoxication given in the last three columns of Table 7.4. The total average cost for Mali is estimated at 570 million CFA francs per year, with a range from 167 million to 1.1 billion CFA francs. The highest contribution to these figures comes from the replacement of labor. Drugs and medication represent a relatively small fraction of the total costs.

These estimates should clearly be considered as indicative and treated with some caution. Most of the data used for the estimates were collected outside Mali. However, due to the absence of national data, this type of estimate is among the few alternative options available to quantify the economic impact of health effects of pesticides in the country. They may serve as a first estimate, awaiting more specific national data to be collected.

Pesticide residues in water

Pesticide residues in (both surface and ground) water may have a harmful impact on human and animal health as well as on the environment in general. Very few studies have been carried out in Mali regarding the presence or effects of pesticide residues in water.

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[8] Although there might be ethical reasons that would suggest to refrain from monetary evaluation of human life, this study follows the arguments and approach used by Pimentel *et al.* (1993) in a study of pesticide externalities in the USA. Estimates based on implicit willingness-to-pay assessments could not be obtained, therefore the average agricultural GDP per worker is used.

The CMDT has, for several years, taken samples of surface and well water in a cotton growing areas of southern Mali, to assess the presence of pesticide residues (Coulibaly and Derlon, 1994; DNH, 1999). We compared the results of these studies with European drinking water norms, since no Malian drinking water norms exist for pesticides (EU, 1975, 1998). For the period 1992-1994, 28% of the samples taken from open wells and drilled (closed) wells exceeded European drinking water norms, and 11% of the samples exceeded the norm for surface water intended for drinking water production. This was the case during at least 7 months of the year.

The replacement cost of this drinking water, with similar residues levels be the rule all over the cotton growing area of Mali, amounts to 44.5 millions CFA francs per year. This estimate is based on the water tariff of the national water company and a water consumption of 3 liters per day for 28% of the 2.8 million inhabitants of the cotton growing zone. Real costs would be higher since water prices in rural areas which are not served by the drinking water grid are often higher than the national water company rates.

Pesticide residues in food

Pesticide applications on food crops may cause residues to remain on agricultural commodities. Furthermore, treatments of pasture (e.g. in the case of locust control) or of animal feed (e.g. cotton seed cake), may give rise to residues in livestock, meat and milk.

Several types of economic costs may be involved. Chronic exposure to residues in food may result in human health costs. Such costs have already been included in the estimate of chronic intoxication discussed above. Furthermore, pesticide residues in food may, if exceeding maximum residue limits, cause the rejection of exported food commodities. With the stricter EU legislation now in place, this problem has become acute for the Malian agricultural export sector.

Unfortunately, data on pesticide residues in food are almost absent in Mali. It is therefore currently impossible to assess their human health and economic importance.

Pollination

Pollination by (mostly) insects plays an important role in the increase of yields and the improvement of the quality of certain crops. Furthermore, certain bee species produce honey and wax.

Crops which benefit from pollination in Mali include cotton, cashew, mango, papaya, cabbage and tomato, among others (Roubik, 1995). However, the economic impact of pollinators for Malian agriculture has not yet been quantified (Dicko, 2000).

Honey production is of increasing importance in Mali. It has been estimated that Mali has about 5 million bee colonies, including those not in hives. Total honey production was about 2200 tons in 1999, and has remained relatively stable over the last 10 years. The yearly production of wax is about 200 tons. The total estimated value of these two products was 2.3 billion CFA francs for 1999 (Dicko, 2000).

No comprehensive studies have been carried out to date on the effects of pesticides on pollinators, pollination or honey production in Mali. However, the risk of negative effects is definitely present because the most important honey producing areas of Mali overlap to a large extent with the cotton growing zones, which have the highest intensity of pesticide use in the country.

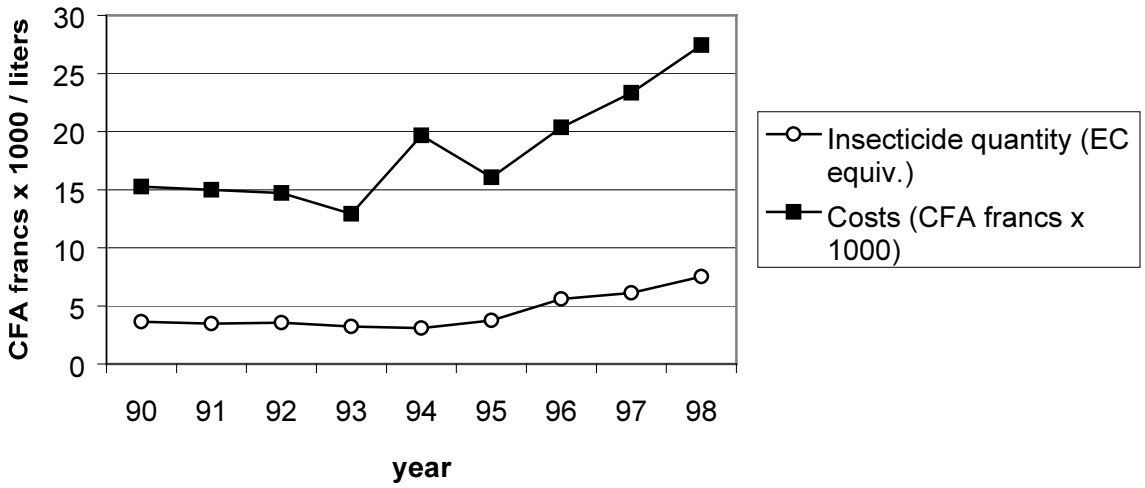
As an example, it has been estimated that 5% of the bee colonies in the USA are yearly killed by agricultural pesticides and another 15% affected in their health (Pimentel *et al*., 1993). If we presume that this is the case for only 1% of the Malian colonies (given the lower pesticide use intensity), then the yearly honey losses would amount to 23 million CFA francs, not including the replacement costs for the hives.

Pesticide resistance, secondary pest development and resurgence

The development of pesticide resistance may cause various economic problems for farmers: an increase in the rate or frequency of pesticide application, a higher concentration of the active ingredient in the commercial formulation to be applied, or a change to a new, more expensive pesticide. Generally, pesticide resistance increases the production costs for the farmer as more resources have to be spent for crop protection. Moreover, if no control alternatives are available, additional crop loss may occur.

It is now recognized that *Helicoverpa armigera*, the American boll worm, has become partially resistant to pyrethroids in Mali as of the late-nineties (PR-PRAO, 2000). Insecticide use intensity has almost doubled since about 1995 (Figure 6.1). Furthermore, the concentration of pyrethroids in the cotton insecticide formulations has also increased by 20%. At the same time, cotton yields have continued to drop (see section 2.3).

Figure 7.1: Average intensity of insecticide use in cotton (per hectare)



One has to note that several other pests which are important in Mali are generally considered to be high risk pests with respect to insecticide resistance. These include the white fly *Bemisia tabaci* and the aphid *Aphis gossypii* in cotton, the diamond-back moth *Plutella xylostella* on cabbage and the aphids *Aphis gossypii and Myzus persicae* on various vegetables (Bashir, 1997; Delhove and Coly, 1999; IRAC, 2000). No data are presently available on the possible appearance of resistance in these pests in Mali, however.

Pesticide use may cause pests which were not yet of agronomic or economic importance to become so, or target pests to newly flare up, because of the disappearance of their natural enemies in the crop. The increased importance of the white fly *Bemisia tabaci* in cotton is an example of a secondary pest developing after widespread insecticide use against other insects (Butler and Henneberry, 1994). There are also indications of secondary pest development after locust and grasshopper control in the Sahel (van der Valk, 1998; van der Valk *et al.*, 1999). Another group of insect pests which has a tendency of becoming important pests after pesticide use are leaf miners (*Lyriomysa* spp.) in certain vegetables. Not yet a problem in Mali, leaf miners have already become a primary pest, in vegetables in Senegal.

If one presumes that the increase in insecticide use in cotton is primarily caused by the development of pest resistance and resurgence of secondary pests, the economic impact for farmers can be estimated. Average insecticide use from 1990 to 1995 was 3.5 liters/ha at a cost of 15,600 CFA francs per hectare. Insecticide use grew on average 1.3 liters/ha per year for the period 1996-1998. For the cotton season 1998/99, the cotton development

organizations distributed an insecticide quantity which is equivalent to 7,5 liters/ha at a cost of 27,450 CFA francs per hectare (Figure 7.1).

In 1998, on average a cotton farmer had to spend 11,850 CFA francs per hectare more for insecticides than in the period 1990 to 1995. For the total of the cotton area, the additional costs are 5.97 billion CFA francs. If subsidies for cotton insecticides are neglected for the time being, the amount represents also the social costs of resistance and secondary pest development. These costs have to be attributed to earlier pesticide use patterns. It can be expected that insect control costs will remain high as long as current pesticide use patterns continue.[9] The steady growth of insecticide use since 1995 suggests that future cost increases can not be ruled out as more pests become resistant to current treatment patterns.

Effects on soil fertility and biodiversity

Pesticide use may have an indirect effect on soil fertility because of the destruction of soil organisms which are responsible for nutrient recycling. Herbicide use may have an indirectly negative impact on the fertility of lateritic soils since it replaces weeding and mechanical soil treatment.

Although the use of fungicides, bactericides, soil fumigants and herbicides presently remains low in Mali, potential negative effects have to be watched closely because of the scarcity of soil resources in the country.

Mali ratified the Convention on Biodiversity in 1995. This international convention aims at the conservation of ecosystems and species as well as the sustainable use of natural resources (CDB, 2000). Mali prioritized 10 sites for biodiversity conservation. Those areas are not located in zones of heavy pesticide use. However, agricultural development, especially for vegetable crops, is expected to expand in the Niger river delta. Also, the area Adrar des Iforas is a locust breeding habitat which might be affected by locust control by insecticides.

Pesticide management costs

Several national or regional agencies are involved in the judicious management of pesticides in Mali. This includes registration, control, extension and research. These activities are often financed by the government and not

[9] In principle, new technological developments might be provided that help to better control the resistant pest complex. However, these will probably come at higher costs or will require upfront investment in research, development and training.

included in the price of the pesticide. Estimates of such pesticide management costs are given below.

Pesticide registration

Pesticide registration in the Sahel is carried out by the regional CSP. The total yearly budget of the CSP is approximately 105 million CFA francs. The agrochemicals industry currently reimburses about 30 million CFA francs of this amount through the registration fees. The rest is supported by the CILSS member states, thus amounting to about 9 million CFA francs per country per year.

Control

In Mali, the control of the distribution and use of pesticides is done by the DGRC. It has an estimated yearly budget of about 47 million CFA francs for its activities on training and control of pesticide use. This is in part funded by the state, and in part by development cooperation.

The DNACPN is responsible for control of the production and formulation of pesticides in Mali. It has an estimated yearly budget of 15.5 million CFA francs. The part of this budget allocated for pesticide control is about 3 million CFA francs.

Extension

Extension and training in the field of pesticide use is carried out by DNAMR, CMDT and other agricultural development organizations. It was not possible to obtain an estimate of the costs of extension specifically for this type of pesticide related activities.

Research

The IER is the lead agency for pesticide efficacy studies in Mali. Since 1999, IER has a policy in which the costs of such studies is entirely paid for by the organization commissioning the study (e.g. pesticide industry, CMDT). As a result, the costs of pesticide efficacy testing are now internalized in the development costs of the pesticide.

Public health

Most of the pesticide applications done for public health purposes have now been privatized. The budget allocated to the National Hygiene Service, which is mostly used for pesticide applications in public buildings, amounts to approximately 12 million CFA francs.

Disposal of obsolete pesticide stocks and used containers

Obsolete pesticides need to be disposed of correctly to avoid spillage in the environment and subsequent damage to the environment and human health. A recent study inventoried obsolete stocks in Mali and reported 192 tons of pesticides to be disposed, as well as approximately 14,000 tons of contaminated soil and 1,600 empty drums and containers. The total cost of the operation was estimated at 1.7 billion CFA francs (DNACPN/FAO, 2000).

Since these (now) obsolete pesticides were accumulated over a period of about 13 years, average annual costs for disposal amount to approximately 134 million CFA francs.

Used pesticide containers are presently thrown away as normal garbage. As such they do not entail a large cost. However, new recommendations by FAO (FAO, 1999) stipulate that pesticide distributors should take back used containers for recycling. Such procedures will, if implemented in the future, add to the cost of the pesticide. No estimates of such cost increases are presently available.

7.3 Summary of cost estimates

The assessment of indirect and external costs of pesticide use in Mali remains incomplete at this stage. This is due to a lack of data on some of the effects which are known to exist. The situation is comparable for other countries where such studies have been undertaken (see for example Ghana, Côte d'Ivoire). However, the available information suggests that externalities of pesticide use should not be neglected when policy decisions are made.

The calculated total costs of more than 6.8 billion CFA francs (about US $ 9.8 million) per year thus represent a considerable underestimate of the true amount. Among the costs that were quantified, two items are most important: resistance of insect pests towards pesticides and human health effects. They represent over 90 % of the total costs (see Table 7.5).

Table 7.5: Assessment of indirect and external costs of pesticide use in Mali

Type of effect	Annual costs (million CFA francs)	Comment	Level[1]
Human health	570		P , E
Disposal of obsolete stocks and packages	134	In case that the legislation is not adapted	E
Residues in water (replacement costs)	44.5	Costs for fisheries and livestock not included	P , E
Residues in food	? ?	No data	P , E
Reduction of pollinators	23	Loss of honey production. Crop loss due to pollinator damage not included	P , E
Pest resistance, development of secondary pests and resurgence of pests	5,970	Only for cotton	P , E
Reduction of soil fertility, loss of biodiversity	? ?	No data	P , E
Environmental pollution from pesticide production sites	? ?	No data	E
Costs of pesticide management	83.5	No data on costs of pesticide extension	E
TOTAL	6,825		

[1] P: private costs; E: externalities

8 Conclusions and recommendations

Agricultural production in Mali has shown a positive development during the last decade. Production growth has been accompanied by an increase in pesticide use. This has been particularly pronounced for cotton production, and most likely also for vegetables. In 1998, the size of the pesticide market was at least 5,400 tons formulated product at a value of CFA francs 17 billion. This represents 1.9 % of the GDP of Mali. Agricultural pesticide use amounts to 4.5 % of agricultural GDP. Therefore, pesticide use is currently an important factor for the economy of the country.

Given the growth of pesticide use in the last five years (11 % in quantitative terms and 19 % in value) and the current emphasis of the government on cash crop production, it is likely that pesticide use will further rise in the future.

The study reveals that there is a lack of reliable information on pesticide use and its negative side-effects. This is the case for every sector concerned (agriculture, public health, domestic use, animal health). Only pesticide use in cotton can be traced to a certain degree. It is therefore likely that the total size of the pesticide market is underestimated.

Globally, more information about the potential negative effects of chemical pesticides on human health and the environment has become available in the last years. However, there is still limited knowledge and awareness about the economic impact of such problems among the key actors in Mali. Furthermore, capacities for improvement in pesticide management and use are insufficient.

Despite the lack of quantifiable information in many areas, the study results show a significant amount of externalities of pesticide use. Following a conservative estimate based on the available data, there are social costs of CFA francs 6.8 billion (US $ 9.5 million) which are not yet internalized in the market prices of pesticides. This is equal to about 40 % of the current pesticide market value. Major costs are found in the area of damage to human health. Also, production cost increased due to pest resistance and secondary pest development. However, the true value of the externalities is most probably underestimated due to limited availability of data.

Despite the privatization of pesticide import and distribution, pesticides still benefit from a number of fiscal and economic incentives. Pesticides are subject to a reduced import tariff. Also, the main parastatal development agencies provide pesticides to farmers in their intervention area on the basis of

subsidized credit. These incentives hamper the adoption of alternative crop protection strategies that could reduce environmental and health externalities.

The main elements of pesticide regulation have been put in place according to internationally accepted standards. It is expected that the full application of the legislative instruments shall contribute to a reduction of unregistered and highly toxic products on the national market. It shall also provide incentives for a more rational use of pesticides.

The results of the study demonstrate that pesticide management needs further improvement and that the use of chemical pesticides should be rationalized. This is expected to contribute to a sustainable path of agricultural development.

Research institutions could make valuable contributions toward the development of alternative crop protection strategies and their adoption by farmers. Priorities for political and financial support should be targeted towards the reduction of the current problems caused by a unilateral dependence on chemical pesticides. Current initiatives for research, development and extension of integrated pest management (IPM) should be further strengthened. For example, farmer field schools have been established in irrigated rice in Selingué and the zones of the Office du Niger with the support of the FAO. In cotton, CMDT is experimenting with economic threshold levels for insect pests which show the potential of cutting current insecticide use levels by half.

Further research is needed with regard to the level of crop losses in the main crops of Mali. This information is essential for assessing the benefits of current pesticide use and determining their optimal use level, including the social costs.

Based on the outcome of the study, we make the following recommendations for pest and pesticide management in Mali. They are to a large extent based on the results of a workshop among key stakeholders of Malian crop protection policy, which was held in September 2000 (FAO/INSAH, 2000).

Regulatory measures for pesticide registration and management have been drafted and partly put in place at national and subregional level during the last decade. The Malian government should finalize the legal procedures to render the institutions fully operational. However, enforcement of regulatory control depends on sustainable financing of government agencies as well as on the awareness of the stakeholders in the product chain.

Pesticides deserve special treatment in the import duty regime. However, reduced import tariffs are not justified because of the significant externalities that pesticide use produces. It is therefore recommended to treat pesticides like other commercial inputs for import duties. Additionally, other measures, e.g. taxes and user fees, should be considered to internalize the externalities into the market price and direct pesticide use toward its socially optimal level. This will be in line with the polluter-pays-principle currently emphasized in environmental policy.

Farmers, extension service and NGO personnel, and other actors in agriculture should be provided with more information about alternatives to unilateral dependence on chemical pesticides. Already existing research results and experiences from pilot projects should be made broadly available. Integrated pest management should be promoted by farmer training programs, especially in pesticide-intensive crops such as cotton and vegetables.

It is recommended to create a data collection system for a comprehensive overview on import, export, production, distribution and use of pesticides in the country. The information is of critical importance for strategy development in the agricultural, environment and health service sectors.

There is an urgent need for a critical analysis of crop loss data which are available in the national and subregional research centers. The analysis should include the effects of different pest management strategies, but not be limited to chemical pesticides only.

The overall profitability of pesticide use in terms of costs and benefits to the national economy should be evaluated in detail. Costs should not only include the private costs to the users, but also the indirect and external costs to the society at large. This includes the impacts on the environment and on human health. It is recommended to undertake more research about the importance of indirect costs of pesticide use in the main crops in Mali. The information collected during this study suggests that there are major costs in the areas of human health and development of pest resistance and secondary pests.

Factors stimulating or discouraging pesticide use should be evaluated by the means of an expert assessment. This would allow policy decision makers to identify the priorities for a reorientation of crop protection policies.

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Annex

Table A-2.1: Cotton export receipts in comparison to total imports and state revenues (billion CFA francs)

Item	Year									
	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**
State revenues (except for development assistance) (1)	116	110	100	105	140	177	217	236	255	273
Cotton exports (2)	56	47	39	40	78	127	133	159	145	143
Total imports (3)	164	130	160	139	249	385	393	439	448	463
Ratio (2)/(3) (%)	*34*	*36*	*24*	*28*	*31*	*33*	*34*	*36*	*32*	*31*
Ratio (2)/(1) (%)	*48*	*43*	*39*	*37*	*56*	*72*	*61*	*67*	*57*	*52*

Source: BCEAO (1999)

Table A-3.1: Comparison of some KR2 pesticide prices (in CFA francs) with those observed on the free market in Mali.

Product	Year	FOB price [1]	Sales price at 2/3 FOB	Real sales price [2]	Market price 2000 [3]
Fuji-One	1994	12 300	8 200	_	4 500
Ronstar	1994	13 400	8 900	_	4 000-6 000
Unden 2% PP	1994	3 500	2 300	500	1 500
Londax	1998	5 410	3 610	_	3 000
Cyanox	1998	14 700	9 800	6 500	_
Dursban 48EC	1998	17 800	11 800	3 000	6 000-9 000

Sources: [1] Touré (1999); [2] SNPV (1994), but remained unchanged since then (DPRPAV, pers. comm.); [3] market survey in Bamako

Table A-5.1: Pesticide imports (in million CFA francs) according to country of supply, from 1996 to 1999

Country	Year			
	1996	**1997**	**1998**	**1999**
France	1198	1371	2436	2608
Belgium – Luxemburg	184	98	494	372
United Kingdom	560	665	182	884
Senegal	24	872	2624	3454
Côte d'Ivoire	2891	4104	3436	1288
Cameroon	437	26	-	-
South Africa – Namibia	118	388	165	97
USA	219	2	5	44
India	371	747	638	702
China	328	185	355	224
Netherlands	52	25	169	532
Switzerland	34	-	129	409
Other countries	396	568	906	1502
Total	6812	9051	11539	12116

Source: DNSI (2000d)

Table A-7.1: Estimation of the number of pesticide poisoning cases

No	Data source	Study population	Type of effects studied	Study results	Extrapolation for the situation in Mali
	National				
1	Hospital statistics, partial coverage	Intoxicated persons seeking treatment	All intoxications	47 acute accidental intoxications related to pesticides and industrial chemicals per year, out of which were 30 fatal	- 329 acute accidental pesticide intoxications per year - 30 to 210 fatal cases in Mali
2	Field study in CMDT zone	Cotton farmers	Acetyl cholinesterase inhibition (occupational)	12% of cases with a level of more than >25% reduction	18,000 persons working in cotton production have to refrain from their activities for at least three days, resulting in 54,000 work days lost
	Other developing countries				
3	Africa	Population working in agriculture	Occupational intoxications	2% of the active population is intoxicated at least once per year	At least 113,000 cases of intoxication related to pesticides per year for all of Mali
4	Field study in China	Cotton farmers	Occupational intoxications	Intoxications with organophosphates and pyrethroides between 0.16% and 11.6%	Between 240 and 17,400 cases of acute intoxications among cotton farmers in Mali
5	Kenya	Agricultural workers	Occupational intoxications	7% of workers intoxicated at least once per year	19,780 cases of intoxications in Mali
6	Côte d'Ivoire	Cotton farmers	Occupational intoxications	- 20% of treatments resulting in intoxication symptoms ; - 0.66 work days lost entirely and 5.02 work days lost partially per household and season	- 30,000 intoxications among cotton farmers in Mali - 66,000 work days lost entirely and 502,000 work days lost partially
	Worldwide				
7	Worldwide evaluation	Active population in agriculture	All intoxications		- Between 1,500 and 2,570 cases of acute intoxications (of which between 6 et 29 fatal cases) per year - Between 1,150 and 1,980 cases of chronic intoxications per year

Sources: [1]Djiba (1997); [2]Cissé and Diarra (1992); [3]Koh and Jeyaratnam (1996); [4]He *et al.* (1993); [5]Mwanthi and Kimani (1993); [6]Ajayi (2000); [7]WHO (1990)

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