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FOOD SECURITY IN WEST AFRICA

Study of complementary tools to integrate cereal market dynamics into the analytical and decision-making process

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SUMMARY

Jointly sponsored by the Sahel and West Africa Club (SWAC)/OECD and the CILSS as part of the International Network on the Prevention and Management of Food Crises in the Sahel (RPCA)[4] agenda, this study comes at a time of dramatic change in cereal prices in the Sahel. On a number of occasions in the past few years, cropping seasons characterised by satisfactory levels of cereal production have nonetheless run up against significant price strains that have consequently made access to cereals more difficult for already cereal-deficient urban and rural households. It was not until the record harvest of 2003-2004 that prices started to decline considerably.

Through this work, the CILSS and the SWAC sought to contribute to redefining the current thinking on crisis prevention and management by more systematically integrating the price dimension into the analysis of food insecurity. The objectives were as follows:

- Increase knowledge of price trend determinants by conducting studies in three countries: Burkina Faso, Mali, and Niger;
- Identify market analysis tools and combine them with other tools for evaluating and preventing food crises;
- Participate in the creation of a regional market information system encompassing all three CILSS' sites which enables it to improve its overall system for monitoring food security.

The results generated by this work can be understood on four different levels:

a. Advancing knowledge of price trend dynamics (functioning of markets)

The use of a data series spanning a long time period offers a new view of market dynamics, and thus one that complements other information gathered from surveys and drawn from existing literature. **More specifically, this perspective highlights the cumulative effect of a series of cropping seasons on both price levels and price trends.** It also reveals in a more systematic manner **interrelationships between the production outputs and markets of different countries of the region**: those between Sahelian markets, as well as those between Sahelian countries and coastal countries of the Gulf of Guinea. Research in this area confirms that there is no longer a juxtaposition of national markets, but rather that we are currently witnessing the gradual integration of markets within a regional zone (the West African region).

b. Enriching the assessment of food insecurity by more effectively incorporating analyses of market dynamics and price trends.

Research conducted in the three countries substantially augmented the body of information currently available to national and regional analysts, thus enabling them to refine their diagnoses of food risks. This study enabled the development of three simple tools for analysing market-related risks:

(i) The use of **principal component analyses** has facilitated the systematisation of approaches as well as the graphic representation of a multi-criteria influence on the food situation (historical series);

(ii) Relatively reliable **March price estimates** made upon the release of the first output estimates in October in order to help anticipate difficult situations based on the precaution principle;

[4] Réseau international de Prévention et de Gestion des Crises Alimentaires au Sahel.

(iii) A **scale of market stress** that takes account of the main parameters determining market trends for any given country. **This scale constitutes a tool for discussion and analysis of market-related food security risks that complements other available tools and approaches** and focuses on the risks associated with both the "availability" and "vulnerability–access" dimensions (observation of agricultural and weather conditions and other types of early warning systems, agricultural surveys/cereal balance sheets, market monitoring, vulnerability monitoring, etc.).

c. Integrating regional data within diagnoses, analyses, and decision-making processes.

The tools developed within the framework of this study will substantially improve the decision-making process, for they **enable a more systematic incorporation of regional data into diagnoses and analyses normally carried out on the national level**. Yet, these tools offer even more than this. **They also integrate parameters from neighbouring countries in order to better understand the evolution of the level of market stress in a given country, and thereby identify its food insecurity risks.** From this perspective, **they open up new opportunities for dialogue and regional co-operation in the area of food crisis prevention.** The availability of analytical and decision-making tools on the regional level will become even more important in the future for two primary reasons:

(i) Markets will play a greater role in the management of food security (given the combined effect of urbanisation and integration);

(ii) Public policy co-ordination will become a key element of the credibility and efficiency of national and regional food security strategies.

Finally, these tools allow the institutions responsible for food security management to **think through and formulate adequate responses to crises by enriching the ongoing debate on the probable impact of various types of national and regional actions on market workings and prices.**

Analyses that effectively predict market stress should allow better-informed choices of the **most appropriate instruments to employ in a given crisis.**

Combining these new quantitative tools with ones already in use, as well as with qualitative analyses based on the expertise of observers and analysts, will pave the way for significant improvements in the capacity to choose the most appropriate tools for coping with different kinds of crises. Depending on the type of crisis and from which corresponding market changes are likely to result, it may be more useful to favour one of the following approaches over the others:

- Food aid, with special care given to volume, localisation, and modes of distribution: whether gift, subsidised sale, food for work, cash for work, etc.;
- More or less large-scale recourse to imports to stabilise or lower prices;
- Strengthening decentralised stocking strategies via cereal banks and other means of village stocking, notably in cereal-poor zones far from urban centres and thus difficult to access during the rainy season (lean period);
- The establishment of operations geared towards the rapid planting of off-season crops;
- Cash-generating operations.

Similarly, **these tools should raise a great deal of interest among managers of national security stocks** (NSS) in order to:

- Decide on the replenishment or technical rotation periods of their NSSs;
- Choose the manner of technical rotation for their NSSs: choice of procurement or marketing zones (in particular, is it possible to procure from the national market without sparking an inflation of grain prices, or, is it more advantageous to favour the regional market in order to limit the impact on prices? The same type of reasoning can be applied to marketing decisions).

These tools should be most beneficial for "average years" during which time the commonly used tools have proven to be inaccurate. Decision-making aids are most crucial during these years, when trends result from a complex interplay of qualitative and quantitative factors, on the one hand, and spatial and temporal ones, on the other, thus making them very difficult to decipher. These are the most common kinds of years. **This type of tool should help food security (FS) managers put their interventions into context as well as enhance their analyses of food risks and their assessments of the probable consequences brought about by their interventions.** For example, a production deficit in terms of consumption needs would be interpreted differently based on whether the previous year was a good one or a bad one, and the appropriate crisis-response instruments would likewise differ.

By cultivating the use of such tools, which bring together national and regional data based on the actual workings of food economies in the region, food security managers in Sahelian countries will effectively multiply the opportunities on the regional map for finding and deploying solutions to food crises. Under these conditions, food crisis prevention and management strategy, in itself, serves as a vector of regional integration. For example, as in the previous case, a production deficit will be filled in a different manner depending on whether the neighbouring countries have substantial volumes of cereal available which they are able to export, or whether they are also dealing with a cereal shortfall. The response entails not only integration within the Sahel itself, but also the integration of the Sahel with the West African coastal markets, a situation this study demonstrates by more precisely measuring the impact of Nigerian, Ghanian, and Ivorian production and trade on food economies of Sahelian countries. This interaction is not a new phenomenon, but a more nuanced understanding illuminates how important it is to move progressively beyond the current regional approach to crisis management, which was originally designed to help the entire Sahelian region cope with its "common climatic risk." Henceforth, both risks and market-related opportunities will require the development of a broader approach to crisis prevention and management encompassing the entire ECOWAS zone.

d. Developing regional market information systems.

This study illustrated the importance of **making rapid progress towards the establishment of a regional market information system.** Using national Market Information Systems (MIS[5]) will help contribute to the crucial task of identifying markets that are truly important for the regional food economy for which should harmonised monitoring efforts should be made (in terms of data collection and processing methods) so as to allow for data comparison. Price monitoring should be paralleled by close observation of cross-border flows. Methodologically, the development of price analyses makes the pinpointing of possible inconsistencies possible, especially those arising between production monitoring and market tracking procedures. By serving as an "inconsistency locator," these analyses can facilitate data verification and the qualitative monitoring of information systems (identification of aberrant price monitoring data, or inconsistencies between production data).

[5] Commonly known by their French acronym, SIMs : Systèmes d'Information sur les Marchés.

Perspectives

First launched in three countries on an experimental basis, this study should now be applied to all of the countries of the CILSS zone and intensified as part of a research-action project. To this end, **it should be integrated into the work programmes of the specialised institutions of the CILSS**—particularly the Institut du Sahel (Sahel Institute) the Agrhymet Centre and PREGEC—in a manner that fosters development within the framework of an ongoing dialogue between information system managers, researchers, analysts, and the users of the decision-making tools for whom this study is mostly intended. Originally conceived by pairing field knowledge with statistical approaches, **the tools** presented in this study **should be progressively fine-tuned and improved by continuing to rely on this combination, as well as by drawing upon feedback regarding problems encountered by their users**. Such feedback should be increasingly forthcoming, as this study could soon be made available to countries seeking to employ such tools. **These are far from highly sophisticated tools demanding considerable means in order to be used. However, their increased use can only be beneficial from the perspective of building collective capacities to assess food situations, opening dialogues, facilitate joint actions, and contribute to decision-making processes.** A management training programme to accompany the transfer of these tools should thus be designed with these considerations in mind.

This set of results was examined by a group composed of information system managers during a September 2003 meeting organised by the PREGEC in Niamey. It was then presented for discussion at the Sahel Food Crisis Prevention and Management Network (RPCA) annual meeting held in Nouakchott on 8-10 December 2003. Given the rather exceptional situation (record cereals crop), price prediction tools signalled the risk of a serious market collapse. Moreover, the debate surrounding price analysis indicated to the CILSS the need to take appropriate steps to facilitate cereal trade outside the region in conjunction with regional institutions and networks of private operators.

In view of the results of the present study, the meeting recommended that the CILSS:

- **Validate the employed statistical methodology and indicators developed for countries not tested in this initial procedure, and use the results for improving the model;**
- **Incorporate the results of this work into its programmes;**
- **Extend the approach to the rest of the Sahelian countries;**
- **Develop the presentation of the decision-making tools;**
- **Strengthen national and regional price analysis capacities as a means of more effectively incorporating analytical tools within strategic approaches to the prevention and management of crises.**

In order to facilitate as far as possible the reading of this synthesis that is based upon extensive statistical analyses, the authors have put the large body of data used in the Annexes, thus permitting specialists to judge the reliability of these investigations for themselves.

INTRODUCTION

Initiated by the Sahel and West Africa Club (SWAC) and the CILSS, this work has been undertaken at a time when markets are playing an expanding role in Sahelian food security issues due to both the dual effect of urbanisation and market liberalisation, as well as to the influence of agricultural and food policies.

Investigations conducted in 2002 have shown that the dynamics of market evolution, expressed in terms of price and exchange volume, has not only resulted from the circumstances of the agricultural season. As a general rule, the conditions within which a cropping season develops determine the level of national production during that year and thus have a strong influence on price levels. However, price level and change also result from the combined effects of the strategies of a range of actors, the production levels of past cropping seasons, the production and market dynamics of neighbouring countries, etc. All these elements will either increase or reduce the impact of a good or bad cropping season.

Also, overuse of the general rule that views prices in close relation with national yearly supply led to considerable judgement errors during previous years. In effect, despite seemingly good or even very good production levels—according to data provided by national, regional, and international systems at different phases in the crisis prevention and early warning process—prices reached very high levels in comparison with price dynamics observed during weak years!

For food security managers, the price issue is obviously crucial. Grain prices are essential for determining population access to cereals, especially for the poorest strata. Yet, these managers face an even greater problem: they must also be able to determine the market impact of interventions made in the name of food security (free food aid or sale at social price, etc.) and to adapt food security support tool management (management of national security stocks, conditions governing calls for tenders, etc.) to the actual market situation. This is all the more critical since states must co-ordinate their food security policies with other economic, agricultural, and trade policies.[6]

To this end, decision-makers continuously look to strengthen their ability to anticipate food crises—to identify adequate tools to cope with them and to evaluate their potential impact. Under these conditions, apparent discrepancies between assessments made on the state of the cropping season and on the level of agricultural supply, on the one hand, and on price trends, on the other, has somewhat compromised the reliability of a crisis prevention approach predominantly based on the analysis of national availability.

At the request of the CILSS and the SWAC, the consultants sought to improve understanding of market workings in the three selected Sahelian countries (Burkina Faso, Mali, and Niger), and to assess the possibility of developing additional decision-making tools that would take into account price and market dynamics to meet the needs of food security policy managers. In 2002, this study took shape initially as a survey of actors in the field. Its results were subsequently discussed and disseminated at the December 2002 meeting of the Food Crisis Prevention Network in Brussels[7] (a summary of its conclusions is annexed to this report). In 2003, this study was complemented by a statistical investigation based on the use of historical data collected by permanent agricultural survey mechanisms and market information systems.

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[6] For example, an UEMOA member country cannot oppose grain exports within this economic zone, even for reasons relating to food security issues, or to the deficit or surplus levels of his country.

[7] Traoré, K., Jeudy, E., Blein, R. (Dec. 2002). Analysis of the Determining Factors in the Escalation in Grain Prices in Burkina Faso, Mali and Niger in the Wake of the 2001/02 Growing Season. SWAC - CILSS – French Ministry of Foreign Affairs; 24 p.

I. ADAPTING DECISION-MAKING TOOLS

"Adapt the instruments to the problems, and not the inverse…": thus concluded the preface of a document published in 1997 under the aegis of the Club du Sahel that sought to summarise the decade-long experience of the Sahelian Food Crisis Prevention and Management Network.[8] While the notion of crisis prevention has remained at the centre of Sahelian food policies since the crises of the 1970s and 1980s, the tools used to accomplish this prevention must naturally evolve to better reflect the diversity of the food crisis situations which the Sahel could now face. Mostly due to climatic factors (crises of either availability or supply), food insecurity now takes on much more varied forms (crises of demand, political crises, poor market conditions, etc.). Moreover, given the poor reliability of data furnished by information systems, the development of methods of checking and cross-checking information,[9] as well as of building analytical capacities now constitute ways to: (i) reduce risks associated with the misinterpretation of potential crisis situations; (ii) improve the oversight and implementation of long-term food security policies (taking into account the need to harmonise multiple policies related to attaining food security); and, (iii) develop short- and mid- term crisis prevention and management strategies.

1.1 INFORMATION SYSTEMS AND THE CHANGING NATURE OF FOOD CRISES

1.1.1 Supply-Deficit Related Crises

The instability of agricultural supply chains in agro-ecological zones strongly affected by extreme climatic conditions represents a major source of food insecurity in economies that still remain primarily rural, where family production is mainly focused on responding to a family's own consumption needs. This explains why the formulation of information systems established in the 1980s and 1990s was strongly influenced by the need for early detection of food crises caused by supply deficits linked to extreme climatic conditions. Within this context, the early warning of national decision-makers and the international community depends on the close monitoring of cropping seasons through the use of several indicators that make it possible to describe the overall state of the cropping season (rainfall, crop irrigation conditions, the phytosanitary state, biomass development, grazing land quality, etc). This body of data is generated either by a national system (GTP), or by regional and international systems (Agrhymet, FEWS NET, FAO/GIEWS). Co-operation between these information systems[10] leads to the formulation of diagnoses and regular opinions on both the state of the cropping season and related production forecasts long before the actual harvests. By September, information systems (GTP on the national level, Agrhymet, FEWS NET and SMIAR on the regional level) are capable of furnishing production forecasts. After that, agricultural surveys further support this information, generating provisional production data based first on producer statements (November) and then on definitive data derived from the measures of yield squares.

Cropping season monitoring indicators enable early identification of serious crisis risks that could translate into considerable production deficits. In any case, by November, the drawing up of a grain balance sheet makes it possible to assess the provisional contribution of production to a country's cereal procurement. Based on a series of estimates (initial and final stocks, consumption standards, import volumes), the balance sheet highlights a provisional surplus or deficit. In the latter case, it is used to determine food aid needs required to re-balance the balance sheet.

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[8] OECD, under the supervision of J. Egg and J.J. Gabas. *La prévention des crises alimentaires au Sahel. 10 ans d'expérience d'une action menée en réseau 1985-1995*; 1997; 207 p.

[9] In particular, by checking the consistency between: (i) cropping season data and results of the agricultural survey, and (ii) production and price trend data.

[10] See *L 'information au cœur de la sécurité alimentaire. Bilan et perspectives des dispositifs nationaux et régionaux*; Diaper; CILSS - EU; 2000.

1.1.2 Access-Related Food Crises

These national or regional cereal balance sheets quickly proved inadequate for fully understanding the food difficulties faced by populations. While they did deal rather schematically with the "availability" dimension of food security, they completely ignored aspects related to market workings and access of populations to foodstuffs. Identification and monitoring systems of vulnerable populations or those at food risk (national FEWS, AP3A regional projects, Vulnerability Analysis and Mapping/WFP) were thus established to complement cropping season monitoring and the cereal balance sheet in order to analyse availability. These systems rely on various methodologies (on their way to being standardised[11] at the regional level under the aegis of the CILSS), but they generally aim to identify the food needs of vulnerable populations and thereby improve the distribution of food aid. This goal sometimes vies with more complex approaches oriented around a fine-tuned understanding of the workings of local economies in risk zones, as well the use of adaptation strategies by households to cope with food risks. This knowledge is aimed more at adapting forms of support or external interventions so as to reinforce the endogenous mechanisms of crisis response and risk control, and enable a sustainable reduction of vulnerability by directly addressing its structural causes.

For vulnerable populations with low production capacities or insufficient monetary resources, food price instability obviously represents a key risk factor. Depending on the level of cereal prices, a household that relies on the market for its supplies may have to spend up to twice as much depending on cereal market prices. Considering the importance of food spending in a poor household's budget, it is easy to understand the importance of prices in the monitoring of food situations and in crisis prevention strategies (cf. infra).

1.1.3 The Growing Role of Markets in Food Security

Liberalisation policies of the Sahel's agricultural and foodstuffs market were introduced over twenty years ago. Contrary to prior policies based on a transaction monopoly granted to the Marketing Offices[12] and the practice of price administration, these new policies corresponded to the sectoral segment of macro-economic adjustment policies.

The cereal market includes imports from the international market as well as a variable part of the overall domestic production. Of the total cereal procurement for all CILSS' countries, the average percentage of imports is around 22% (an average calculated from the last three cropping seasons). The quantity of production put on the market, however, is not as well known. The authors of a 1999 study on changes in the cereal markets[13] reiterate the usual figure of 15% of net production (Diaper data) while expressing disbelief that this type of data is not regularly updated by statistical systems. Since this time, knowledge of this aspect of the Sahelian cereal economies does not seem to have noticeably progressed.[14]

Despite liberalisation, prices have remained volatile and today still exhibit very strong inter- and intra-annual fluctuations. In high potential zones, where cereal production benefits greatly from the spread of technical progress (cotton, maize, and rice zones), price (level and relative

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[11] Research on the "standardised framework of permanent analysis of common state of vulnerability in the Sahel" involving the CILSS, USAID, WFP, FEWS NET, FAO, MIFRAC, CARE and the European Union.

[12] A theoretical monopoly, as, in practice, the Offices never managed to carry out their mission.

[13] Egg J., Merdaoui F., Gabas J.J., Coussy J. ; Synthèse de l'évolution des marchés céréaliers dans les pays du Sahel : éléments de diagnostic et de mise en perspective. Draft 14/11/99; 38 p; Club du Sahel-OCDE.

[14] New studies, however, should be mentioned. A recent study on cereal sales in Niger carried out by the SIMC (K.Kouyaté, S. laouali Addoh and A. Samaila – June 2002) updated our knowledge of the organisation of the actors and trade circuits, marketing strategies, and the impact of subsectors and regional markets on Niger's cereal procurement.

stability), can represent a form of incentive for net surplus producers. However, for a majority of Sahelian producers, who are net cereal buyers, high prices affect the degree of family food security by raising the buying cost of cereals. The improvement of prices constitutes a brake on intensification, on the adoption of more costly techniques, etc.

Finally, due in part to the present pace of urbanisation in the Sahel (several countries already have predominantly urban populations), an increasing and irreversible trend towards market-based food supply is now taking shape.

For all of these reasons, market monitoring is indispensable, both for evaluating the food situation of different sectors of the population, and as a tool for aiding the decision-making process.

Paralleling market liberalisation, most countries set up information systems to monitor cereal and sometimes livestock prices for a sample group of markets (rural production markets, urban markets, rural consumer markets). These market information systems (MIS) were designed with a dual goal in mind: first, to inform economic operators and different industry actors so as to reduce the information imbalance between them and thus improve the workings of the market; and secondly, to inform decision-makers to better enable them to orient their policies and measure the impact of their decisions on market trends. From a food security standpoint, the market data furnished by these information systems progressively came to be used as parameters for guiding food situation appraisals. In general, price analyses corroborated cropping year assessments, while price trends in consumer markets permitted the analysis of access-related risks.

During the previous few agricultural seasons, the issue of cereal prices was central to food security debates. While production levels reported by information systems were relatively high, prices nonetheless reached abnormally high levels—above those witnessed even during the most difficult of cropping seasons. Deemed positive for producers, this price escalation accentuated the difficulties of supplying consumers in general, and especially vulnerable populations and deficit producers who are net cereal buyers. In addition to the need to understand the workings of price dynamics, this new situation demonstrated that what is good for food security in the short run (low prices) is not necessarily favourable to agricultural development over the long term, which necessitates prices remaining sufficiently stable and profit-yielding. Conversely, high prices that are favourable to producers in cereal production basins do not necessarily help meet the food needs of poorer populations. These divergent interests highlight the importance to not consider food security as strictly market related, but rather as a public good requiring—as the case may be—arbitration by the collectivity (the State) in the name of the public good. This arbitration must notably be sought out for the purpose of defining a range of "compromise prices" which serve as sufficient incentives for producers to consider cereals as "cash crops" and choose to invest in them over the long term, but not so much that it impedes answering the food needs of those households who rely on the market.

Finally, relying on reassuring information from agricultural surveys on cereal supply levels, the public authorities of certain Sahelian countries sought to take advantage of this favourable situation to replenish national security stocks. The calls for bids in this perspective increased market stress and amplified price hikes (announce effect), making cereals even less accessible for the population. Moreover, efforts to rebuild stocks remained, on the whole, unsatisfactory.[15] In Burkina Faso, the SONAGESS obtained only 4,664 tonnes out of the planned 21,000. The OPAM in Mali collected only 5,000 tonnes on the basis of a bid for 14,000 tonnes. Moreover, no purchases were made in Niger even though 25,000 tonnes had been planned.

[15] Traoré K., Jeudy E., Blein R. *Analysis of the Determining Factors in the Escalation in Grain Prices in Burkina Faso, Mali and Niger in the Wake of the 2001/02 Growing Season*. SWAC - CILSS – Ministry of Foreign Affairs. Dec. 2002. 24 p.

These events are notable in that they remind us of the importance of the market in the management of food security and the need to better integrate market data in present and provisional analyses, as well as in prior evaluations of public decisions.

1.2 THE EVOLUTION OF DECISION-MAKING AID NEEDS

The region seems well equipped for decision-makers to identify food crises resulting from a deficit supply of agricultural products early on and to determine quantitative needs in order to minimise the risks of supply interruption. This risk is furthermore clearly reduced today as the Sahel is better connected—less isolated than in the past. An accrued dependence on coastal or international markets no longer poses major difficulties. Difficulties subsist, however, in the transport of cereal to very remote regions during the hot season mainly due to the bad state of transportation infrastructures.

Moreover, significant efforts have been made to improve the detection of vulnerable populations and the risks of supply interruptions these households face during shocks. However, it must be noted that above and beyond methodological problems, the monitoring systems of vulnerable groups generally remain extremely fragile, and even absent or very deficient in certain countries.

At the same time, with food security increasingly relying on trade exchanges, the issue of market mechanics has become more important than it was in the past.

Cropping season monitoring systems were developed so as to prevent and anticipate supply crisis risks (availability). The FEWS were conceived to provide early identification of the risks of crises associated with difficulties faced by households in accessing supplies. However, market mechanisms and price trends are still not, for the moment, the objects of sufficient analysis so as to understand and anticipate their evolution and therefore the food risks that certain contexts can engender. Also, decision-makers do not have access to decision-making tools that would allow them to base their interventions on estimations of the probable impact of their decisions on market trends and thus on supply conditions for populations.

The coming months will surely reveal the intricacies of the interplay between food security tools and the market and the difficulties entailed in understanding and managing them. Two examples chosen from classic food security management tools illustrate this complexity.

Management of national security stocks: they have been supplied in recent years at relatively high rates (ex: 184,000 CFA Francs/tonne in 2002 and 167,500 CFA Francs in 2003 in Burkina Faso) due to persistent market stress. Throughout the 2002/2003 cropping season, prices started rolling back,[16] a situation that continued into the lean period on most of the Sahelian markets, partly in anticipation of excellent production levels in 2003/2004. If these trends are confirmed, prices will certainly drop dramatically. Sales based on public bids carried out with a view to technical stock rotation will foster the flow of large quantities of cereals into already sluggish markets. Rather than contributing to market stabilisation and price regulation, public intervention risks amplifying the usual effects of surplus production.

[16] In 2003 the average price was of 172,000 CFA Francs per tonne in March and 163,000 in May.

The supply and management of cereal banks: following the "basic rules" of good management, cereal bank managers generally tend to supply the banks at harvest time when prices are low and then resell the stock during the lean period when market prices are high. The price gap allows for a sufficient margin to cover expenses (losses, stock maintenance and processing, store maintenance, manager's pay, etc.) and ensures the economic viability of the bank, thus enabling it to fulfil its mission to provide food security to households in the village where the bank is located. This price trend dynamic is common during average years and more so in years of deficit production. However, in a situation of "overproduction," prices can continue to fall until the lean period. By reselling its stock at a loss, the bank runs the risk of de-capitalising and depleting its working capital.[17] If the next cropping season encounters tougher production conditions, cereal banks then need to supply themselves again at high prices. Under such conditions, the working capital can no longer purchase sufficient quantities to meet village needs. The capacity of cereal banks to assume their mission is therefore jeopardised.

More generally, beyond these two examples, multiple interventions to maintain food security also have an influence on markets. How can we decide in an objective and informed way what should be the conditions of cereal purchases intended for food security interventions: should cereals be bought on the domestic market to maintain prices, or rather on the regional or international markets? Should national security stocks be replenished through call for tenders on the national market? Or rather on the regional market to lessen the impact on prices? On what date should this call for tender be made to influence market prices or to protect them? In light of current market conditions, should the replenishment of stocks or the mobilisation of food aids held by the WFP or certain NGOs be conducted on the national, regional or international markets? Etc.

For public decision-makers and the heads of agencies and NGOs supporting aid programmes and food security, it would thus appear absolutely essential to improve the comprehension of market workings in order to develop the capacity to anticipate and to have access to decision-making tools so that they may intervene in situations of food insecurity with a better appraisal of the probable impact of the envisioned measures on market trends.

[17] This is known as the phenomenon of working capital erosion, which explains in large part the problems the CBs encounter and which leads to the regular re-capitalising of these cereal banks.

II. KEY ISSUES

Against this backdrop, this study seeks to contribute to three current debates:

a. Is it possible to **improve and complement food security diagnoses** by drawing on a thorough analysis of market dynamics and a more refined understanding of price trend determinants? The objective is to fine-tune the analysis of access to cereals, and thereby improve forecasting of food security risks for different socioeconomic groups, including the more vulnerable groups that depend on markets for their food supplies.

b. Does the availability of historical market data series (over 10 years) enable the **development of decision-making tools** that can provide decision-makers—in conjunction with other forecasting and early warning systems—with opportunities to improve oversight of their crisis prevention and management strategies, and enhance their abilities to anticipate future developments? Since they are based on a more subtle analysis of market dynamics, can these tools enable decision-makers to more effectively assess tade-offs and make decisions in favour of food security, which is now considered to be a public good?

c. Do the regional integration of production and price data and the development of tools based on multi-country analyses make an **increase in the added value generated by regional co-operation in the field of food crisis prevention and management** possible**?** Would this then contribute to the development of responses to crises that more efficiently take into account interdependencies between countries and issues associated with the integration of economic and commercial zones?

The study was carried out in three phases. The first involved a series of investigations conducted in 2002 in three countries (Burkina Faso, Mali, and Niger) so as to identify the reasons put forward by different groups of actors and national services to explain price increases. This work made it possible to select a group of qualitative determinants of price trends. The second phase consisted of employing the quantitative data over a long period (per capita output, prices on different types of markets) in order to statistically analyse the qualitative relations witnessed during the first phase. Finally, the third phase involved the development—based on these series of historical data and a basic knowledge of cereal market dynamics—of an integrated tool (production, price) for analysing probable market trends designed to enrich assessments of food security risks or market malfunctions.

Some of these results were presented and discussed at the Sahelian Food Crises Prevention and Management Network (RPCA) annual meeting (in Brussels in December 2002). The remaining results were presented in Niamey during the PREGEC meeting in September 2003, and then once again during the December 2003 annual Network meeting in Nouakchott.

III. THE PROBLEM

The main question to be answered during the course of this study was whether an understanding of the workings of national cereal markets based on analyses of historical series of cereal price and production data can lead the way to developing an effective tool to predict short-term market trends.[18] A related question involved determining if this tool could eventually serve as a means to forecast and make regionally integrated analyses of market dynamics.

Finally, taking into account existing (quantitative and qualitative) data and different methods of statistical analysis, the objective is to find a method that can systematise the analytical framework of cereal market mechanisms.

Since the 1980s, numerous studies have been conducted on the impact of the cereal market on food security. These studies provide some of the groundwork for the current hypotheses.

To this day, every country has at its disposal data series extending back over a dozen years that can support this kind of inquiry. The study presented here covers three countries: Burkina Faso, Mali and Niger.

IV. DATA AND METHODS

4.1 PRODUCTION DATA

These data are drawn from services and administrations in charge of agricultural statistics that produce annual studies each year. Their official names vary according to the country: Enquête Permanente Agricole (EPA) in Burkina Faso and Enquête Agricole de Conjoncture (EAC) in Mali. These studies use a sample design intended to yield national cereal production estimates within an acceptable margin of error. However, most studies concede that the further one goes into lower subdivisions the less reliable the estimates become. Thus, these investigations determine the gross production, from which available production is calculated by deducting losses and seeds, which are in the order of 15% of gross production.

We have used the ratio of available production to the estimated population on 30 April 2004 to obtain the 'pn' variable, which represents per capita production. Using per capita net production makes it possible to think in terms of the satisfaction of cereal needs per head, making it easier to draw comparisons with apparent consumption and the consumption standard, although the latter is debatable given the changes in eating habits observed over recent decades.

Given the lack of relevant data on regions within each country as well as of data on cereals supply and/or the volume of market transactions, we make the assumption that gross supply calculated using figures for net per capita availability is a good approximation of the 'supply-demand' relation on the markets.

4.2 CEREAL PRICE DATA

Market Information Systems (MIS – SIMs in French) were set up to provide governments with information on the price of major cereals, to help them improve their management of national

[18] To appraise the probable price trend during the lean period, upon the release of the first provisional production estimates in October-November,.

food security stocks, and enhance market transparency for other actors in the industry (producers, traders, and consumers).

In all CILSS countries, such a mechanism collects price, and sometimes supply, data based on a market sample according to the following typology:

- ✓ *Rural markets* in production zones, in order to determine producer and/or collector prices;
- ✓ *Consumer markets* in urban centres and deficit zones, to determine consumer prices;
- ✓ *Border markets,* which might be either consumer or rural markets, to evaluate cereal flows with neighbouring countries.

Price data are collected weekly and are classified as follows:

- ✓ *Producer prices,* defined as the transaction prices between producers and cereal traders; this price depends more on the type of market than on the actors involved;
- ✓ *Collector prices,* which are close to the producer price, except that cereals are traded outside the market*;*
- ✓ *Consumer prices,* collected at the consumer centre level, between retailers and consumers.

In this study, we have favoured the concept that determines price according to the type of market, taking into account its degree of urbanisation and its geographical and agro-climatic location. Indeed, in urban centres, transactions between producers and consumers are insignificant compared with those between traders or wholesalers and consumers. Conversely, on rural markets in agro-climatic zones favourable to cereal production, transactions between producers and collectors, etc., are more significant. As a result, there are two distinct types of markets, each corresponding to a type of price – producer price on rural production markets and consumer price in urban consumer centres.

4.2.1 Selecting the Cereal for the Analysis

The issue here is whether to use the prices of all the cereals currently consumed – using average prices or synthetic indices or even composite prices, which take into account the respective weight of each cereal in the population's diet based on apparent consumption – or if a single cereal should be considered as representative of the Sahelian diet.

Different variables have been calculated for the three staple cereals of the standard diet (millet, sorghum, and maize), which represent 70% of the food ration of the population of Sahel:

- ✓ Simple monthly averages of these three cereals, per market and per year;
- ✓ Implicit price indices, with a base of 100 for the month at the beginning of the series for the last ten to twelve years;
- ✓ Composite prices based on the average apparent consumption of each cereal on the cereal balance sheets.

Each of these variables was used in statistical analyses – i.e., in a study of the correlations and the principal component analyses. The statistical results obtained were almost identical leading to the conclusion that in this context millet, a key cereal in Sahel, could be taken as a sufficient indicator in the analysis of market mechanisms. Moreover, one can also assume, depending on production conditions in the Sahel and the workings of markets, that price trends always move

in the same direction over the medium to long term, even though price levels differ for each cereal and the magnitude of the deviations varies from year to year.

4.2.2 Selecting Representative Markets in Each Country

Various country studies highlight the relationships between cereal markets within a single country, between markets in neighbouring countries, and even, sometimes, between those in countries that do not share a border. Commercial networks for cereals run from rural zones of high production potential to collecting centres or secondary markets, all the way to consumer markets in urban areas or in zones of low production potential.

The choice of market sample, whose price variations during the study period will be analysed, is based on the knowledge of the role of each market at the national and regional levels, as well as on the exhaustiveness of the price data series. *At this stage, we should point out that our selections could be improved by the MIS[19] teams, so as to obtain more representative samples nationally and possibly more coherent results from the analysis of cereal market mechanisms.*

Table 1: Representative Markets, by Country

Type of Market	Mali	Niger	Burkina Faso
Consumer	Ségou	Agadez	Bobo-Dioulasso
	Gao	Tahoua	Ouahigouya
	Bamako	Niamey	Dori
			Ouagadougou
Production	Koutiala	Dosso	Djibasso
	Dioro	Maradi	Dandé
		Zinder	Léo
			Pouytenga

4.3. STATISTICAL METHOD

The choice of statistical method depends on the nature of the data being analysed, but above all on the objectives sought. We are attempting to describe the trend in cereal prices, using that of millet, over years in relation to national production and regional context. However, it is very reductive to assume, a priori, that the development of cereal markets depends solely on production data. It is for this reason that we are attempting to determine, in statistical terms, the relation between price trends and production levels. The component of price variation that is not due to the production threshold, and to the seasonal variations linked to it, is difficult to model, or, in any case, would require a more sophisticated study. The statistics literature offers different methods for studying the trends of variables such as price and commodity production through time: these include, among others, methods of analysing chronological series, like the decomposition method, the Box-Jenkins method, etc. These methods require conditions that the available data do not meet. Moreover, our aim is not to predict prices but to highlight the main elements that determine the market strategies of actors who are trying to solve the various

[19] SIM – Système d'Information sur les Marchés - in French.

problems with which they are faced.[20] For example, how does the market react after two consecutive years of good cropping seasons, when the cropping season has been poor in the neighbouring country? What happens in the context of a fairly good agricultural season preceded by a poor one, if in one or several neighbouring countries the situation has been average? Various possible combinations can be outlined and, in each case, industry actors will develop strategies that will not be systematically the same, but which will fit into a set of imaginable or known possibilities.

Two statistical methods have been used to analyse market mechanisms:

a. ***Principal component analysis (PCA),*** *which is used to interpret relations among a series of interdependent variables in order to reduce the essential information provided by these directly observable variables into a limited number of fundamental variables which cannot be directly observed.*[21] One begins with a large number of variables: 12 monthly prices per year, per capita net production per year for each country in the study and for all the countries with which cereals are traded. The PCA individuals are the 'market year' couples chosen for this purpose. The ultimate objective is to reduce the information provided by all these variables to two or three principal components, to examine the variables linked to them, and, especially, to project, in the space defined by the straight lines representing these components, the markets over the years in order to highlight coherent sets depending on the selected principal characteristics. Finally, PCA results will be used to create a scale of the stress level of the cereal market depending on the principal determinants.

b. ***Multiple regression*** *is used here not for month by month price forecasts but to estimate in November or December the price in March of the following year.* Indeed, as we will see later, in order to use PCA results for prospective purposes, other than for cereal production that remain only forecasts, March prices must also be estimates since they are to be determined in advance. Multiple regression has been described by Chris Chatfield[22] as a means for making predictions in the case of certain economic studies, for instance, in which sales depend on stocks or on economic indicators. *In fact, this is an approach that combines the results of regression proper with the knowledge or the subjective or empirical perception of the people involved in monitoring the market*. We recommend this approach, which, in not locking in the results of the estimates, allows for the possibility of forming assumptions within the limits of plausibility based on field observations and to adjust the estimates in turn. For example, in the model for Burkina Faso in 2003, it is reasonable to take into account, first, the impact on maizeimports on the closure of the border with Côte d'Ivoire and, second, the impact of the results of the 2001/2002 cropping season on the assessments of industry actors. This kind of information cannot be ignored in interpreting the results of the prevailing model. Conversely, in Mali, the exceptional imports of corn from northern Côte d'Ivoire must be taken into account in order to adjust projections.

The statistical parameters of all methods used are further developed in the statistical annex to this report.

[20] COMAC, Cereal Market Information Systems, Document n°2, 1990

[21] Analyse statistique à plusieurs variables, 1975, Les presses agronomiques de Gembloux, A.S.B.L.

[22] The analysis of time series, Fifth edition; Chapman & Hall/CRC, 1996.

4.4 OUTLINE OF THE PROCESS

The general approach recommended here is recursive, combining the results of PCA and multiple regression to allow for a determination on this basis of a **scale of market stress,** bearing in mind that this is not an end in itself but a tool for interrogating all the available information, its coherence and plausibility. This approach fully recognises the need to avoid the pitfalls of unilateral methods of analysing the food situation.

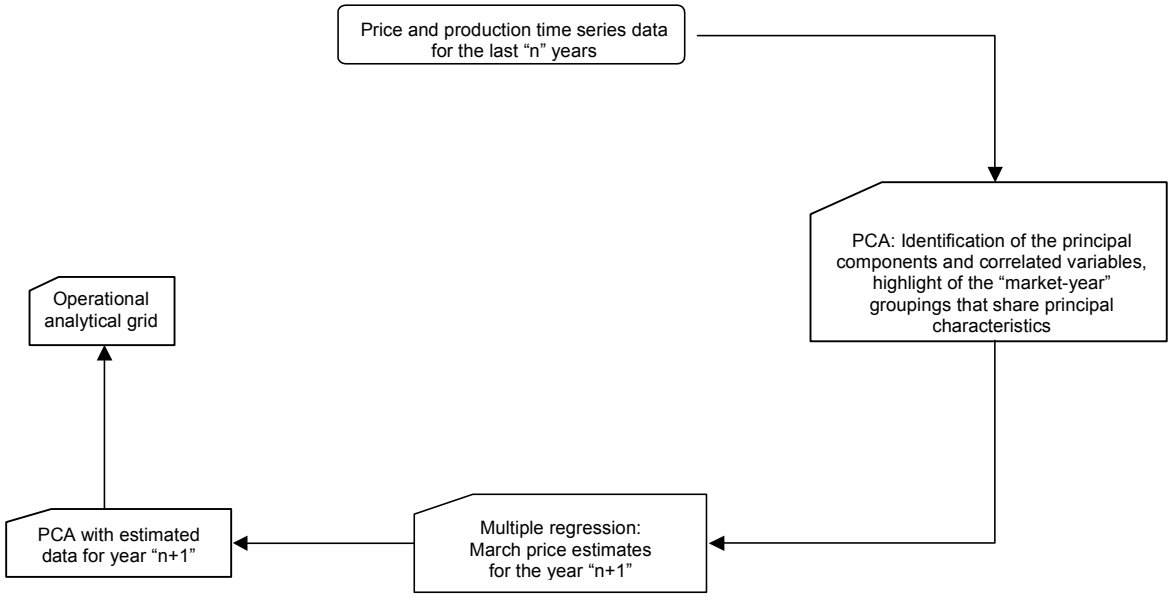

Figure 1: General Outline of the Process

V. RESULTS AND INTERPRETATION

5.1. ANALYSIS OF MARKET MECHANISMS

We use PCA to describe and interpret relations between prices from month to month over the course of a year and the levels of per capita production in different years, for both the country under study and neighbouring countries. Although qualitative analysis of cereal market mechanisms, based on studies of industry actors, demonstrates the existence of these relations, it can neither quantify them nor classify them hierarchically. The aim of PCA is to achieve such quantification and hierarchisation for a 'reasonable' number of variables.

5.1.1 The Case of Burkina Faso

PCA is based on the average monthly prices on selected markets, as well as per capita crop production for 1992/1993 to 2001/2002 in Burkina, Mali, Côte d'Ivoire, Niger, Ghana, and Benin. The neighbouring countries were not systematically selected but chosen based on the cereal flows that have been observed among them. The flows between Mali and Burkina are traditional and can include all the main cereals. With coastal countries, maize flows toward Burkina while millet and sorghum flow from Burkina. Regarding Niger, Burkina can serve as a collecting site for Nigerian traders or as a transit country for cereals coming from Mali or Côte d'Ivoire (maize).

- Selecting the principal components:

Selection was made through a close study of the statistical parameters of the PCA, such as the eigenvalues and their proportions, which are part of the variability of the data cloud accounted for by each. The following chart contains this information:

Table 2: PCA Eigenvalues for Burkina Faso

Eigenvalues	2.711	1.127	0.624	0.396	0.141
Proportion	0.542	0.225	0.125	0.079	0.028
Cumul	0.542	0.768	0.892	0.972	1.000

Thus, the first component accounts for 52.2% of the variability, the second for 22.5%, and the third for 12.5%, i.e., a total percentage of 89.2%. The other two components are considered to be negligible for practical reasons in interpreting the results. Therefore, we will retain these three principal components in what follows.

Table 3: Correlation Matrix between Variables and Principal Components in Burkina Faso

Variables	PC1	PC2	PC3
px09[23]	0.466	-0.507	-0.038
px15 [24]	0.553	0.128	-0.051
pnBF [25]	-0.259	-0.805	-0.303
pn-1 [26]	-0.451	0.242	-0.637
pnML [27]	-0.454	-0.146	0.706

[23] Price in September.

[24] Price in March.

[25] Production year n for Burkina Faso.

[26] Production year n-1 for Burkina.

[27] Production year n for Mali.

These correlations are interpreted as follows:

(i) PC1: the first component reveals the opposition between production and price levels (positive and negative correlations); on the whole, weak output levels result in high market prices and high output levels in low prices.

(ii) PC2: the second component allows us to separate, in the projection of data clouds, 'market year' couples in the plane formed by PC1 and PC2, for which there are a series of agricultural seasons. Indeed, the market does not react in the same way to a series of good cropping seasons, a series combining good and less good cropping seasons, etc. This is, in fact, the measurement of the residual impact of a past cropping season on the following one.

(iii) PC3 is more difficult to interpret. Indeed, this axis enables us to differentiate between very close years in the first two components by taking into account cereal flows with Mali. It contrasts Malian production for the ongoing year with that of the preceding agricultural season in Burkina. It charts the relative impact of Mali's production level on the Burkina market, in the short term. These two countries traditionally trade in cereals, but the data points to the existence of a production threshold in Mali below which the Burkina market becomes more sensitive to Malian demand.

The projection of variables and individuals on the planes formed by the axes of the various components are further developed in the statistical annex. In outline, the basic mechanism of the cereal market in Burkina Faso is as follows:

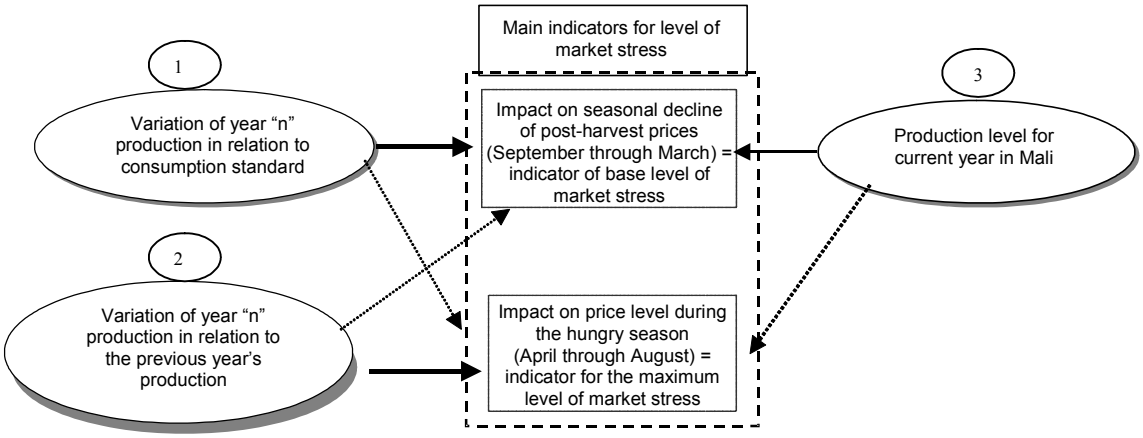

Figure 2: Outline of the Market Mechanism in Burkina Faso

5.1.2 The Case of Mali

The data series starts with the 1993/1994 agricultural season, since older price data was not available. The database also includes average monthly prices on selected markets and per capita cereal production, as well as the production levels for the following countries: Burkina Faso, Côte d'Ivoire, Mauritania, and Senegal.

The eigenvalues in this case show that the first two principal components already account for 82% of the market trend. The third component appears useless here since taking it into account would only very marginally improve the interpretation of the development process of markets in Mali.

Table 4: PCA Eigenvalues for Mali

Eigenvalues	3.1398	0.948	0.6553	0.2024	0.0544
Proportion	0.628	0.19	0.131	0.04	0.011
Cumul	0.628	0.818	0.949	0.989	1

The interpretation of the two principal components retained can be synthesised as follows:

(i) PC1: the first component highlights the production-price relation in opposite correlations;

(ii) PC2: the second component measures, first, the impact of two consecutive agricultural seasons on the price levels between the harvesting period and the beginning of the lean period; and, second, the relative weight of Mauritanian production via its demand for cereals on the Malian market. The former country, chronically in deficit, will impact the Malian market depending on its own level of production, with sharp decreases in production triggering higher demand on the Malian market and vice-versa.

Table 5: Correlation Matrix between Variables and Principal Components in Mali

Variable[28]	PC1	PC2	PC3
px09	0.47	-0.069	0.618
px15	0.466	-0.463	0.295
pn-1ML	-0.373	-0.727	-0.049
pnML	-0.426	0.401	0.63
pnMAU	-0.492	-0.301	0.361

We expected a reciprocally significant relation for the production level in Burkina on the Malian market. This relation does exist, but it is not determining for the Malian market. Indeed, barring a profound change in the future, Mali will continue in its longstanding role as West Africa's granary. The Malian market seems to be 'accustomed' to transfers of cereals to Burkina and inversely, the Burkina market is very sensitive to cereal demand from Mali. The variables and individuals projected in the planes formed by the axes of the various components are further developed in the statistical annex. In outline, the basic working mechanism of the cereal market in Mali is as follows:

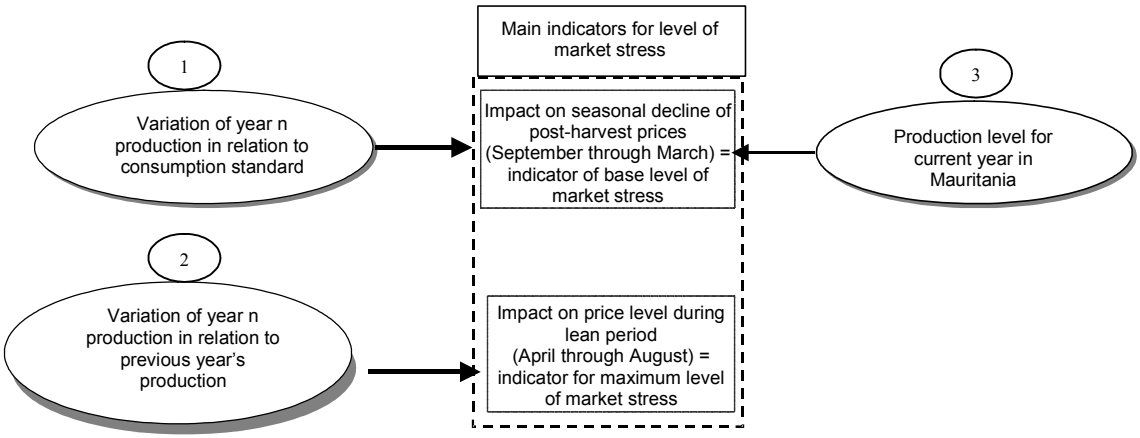

Figure 3: Outline of the Market Mechanism in Mali

[28] ML = Mali; MAU = Mauritania.

5.1.3 The Case of Niger

The data series begins with the 1990/1991 agricultural season. In addition to prices and production in Niger, production levels in Benin, Burkina Faso, Mali, and Nigeria have been taken into account.

Three principal components have been selected for the interpretation of relations between production levels and prices, depending on the eigenvalues of the principal components. The combined proportion of the variability of the data cloud accounted for by these three components is 89%.

Table 6: PCA Eigenvalues for Niger

Eigenvalues	2.3798	1.3148	0.7755	0.4342	0.0956
Proportion	0.476	0.263	0.155	0.087	0.019
Cumul	0.476	0.739	0.894	0.981	1

The correlations between the initial variables and the principal components are interpreted as follows:

(i) PC1: The first component has the same significance as in other countries, except that in this case Nigerian production is more determining than local production itself. Monitors of the Nigerian market think that this finding should also be linked to the trend in the value of the naira (the Nigerian currency). Indeed, the direction of flows is highly dependent on the value of this currency against the CFA franc. The weight of the current season's crop only figures significantly in the second component.

(ii) PC2: The second component enables us to measure, on the one hand, the residual impact of one cropping season on the other and, on the other hand, the impact of the current year's production on the development of the market in the post-harvest period – hence the average yet positive correlation of the price in March (px15) on this axis.

(iii) PC3: The third component measures the relative weight of Nigerian production over two consecutive seasons. In other words, if, for example, Niger has two consecutive good cropping seasons, Nigeria's impact on the trend in prices tends to decrease.

Table 7: Correlation Matrix between Variables and Principal Components in Niger

Variable[29]	PC1	PC2	PC3
px09	0.587	0.005	-0.151
px15	0.579	0.305	-0.183
pnNg	0.17	-0.682	0.601
pn-1Ng	-0.031	0.659	0.733
pnNGA	-0.539	0.08	-0.213

The projection of variables and individuals in the planes formed by the axes of the various components are developed in the statistical annex. In outline, the basic working mechanism of the cereal market in Niger is as follows:

[29] Ng = Niger ; NGA = Nigeria

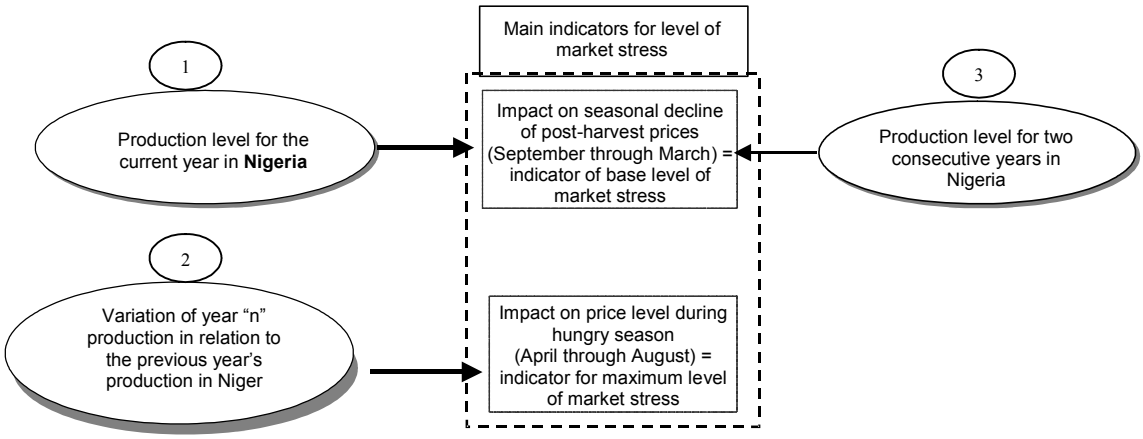

Figure 4: Outline of the Market Mechanism in Niger

5.2 ESTIMATE OF MARCH PRICES

The aim of this estimate, as has already been stated, is to obtain a price value for March so as to use the PCA in a prospective manner. Indeed, when forecasts for the agricultural season are released, the prices for the month of March, considered as basic indicators of the market trend for the upcoming lean period, are missing. The choice of multiple regression is justified, as earlier stated, by the fact that qualitative information from various sources makes it possible to readjust estimates on the basis on various assumptions about production levels and not to be locked into absolute certitudes. Thus, based on data from agricultural studies, one could make a low assumption or use the reference values of market specialists and actors, and the most probable situation can be determined based on the initial market reaction.

5.2.1 Burkina Faso

For production markets (Djibasso, Dandé, Léo and Pouytenga), the best regression equation is as follows:

$$px15 = 274 + 0,405\,px09 - 0,779\,pnBF - 0,452\,pnML \quad (1)$$

This equation reflects the September price (px09) and the current year production levels in Burkina (pn BF) and in Mali (pn ML). The resulting estimates, as well as their confidence intervals (CI) and the values observed for the year 2003, appear in the following chart:

Table 8: Price Estimates on Production Markets in Burkina Faso for March 2003

Market	Estimate	CI (95%)	Observed Values
Djibasso	101	88-114	107
Dandé	108	94-122	ND
Léo	118	101-134	106
Pouytenga	109	95-124	129

For consumer markets (Bobo-Dioulasso, Dori, Ouagadougou and Ouahigouya), the best March price estimate is given by the following equation:

$$px15 = 281 + 0,406\,px09 - 0,715\,pnBF - 0,492\,pnML \quad (2)$$

The estimates for March 2003 are:

Table 9: Price Estimates on Consumer Markets in Burkina Faso for March 2003

Market	Estimate	CI (95%)	Observed Values
Bobo-Dioulasso	139	125-152	184*
Ouahigouya	136	123-149	150
Dori	150	133-167	204*
Ouagadougou	136	123-149	143

Depending on the markets, estimates are more or less close to real values. Notice the very high observed prices in Bobo-Dioulasso and Dori over this period, for which nothing seems to account in principle. After verification of the basic data from the MIS, it turned out that errors in weights are the source of these high prices. The more these estimates approximate real values, the better the position of the 'market-year' couple will characterise its situation for the year to come.

5.2.2 Mali

The attempt to determine the multiple regression equations that best estimate prices for the month of March have led to the following equation for consumer markets:

$$px15 = 197 + 0,417\,px09 - 1,06\,pnML + 0,765\,pnMAU \qquad (3)$$

and the following for production markets:

$$px15 = 186 + 0,429\,px09 - 1,10\,pnML + 0,692\,pnMAU \qquad (4)$$

Applied to the 2002/2003 cropping season, these regressive equations yield the following results:

Table 10: Price Estimates on Consumer and Production Markets in Mali for March 2003

Type	Market	Estimate	CI (95%)	Observed Values
Consumer	Ségou	133	121-145	150
	Gao	141	128-154	175
	Bamako	145	131-159	184
Production	Koutiala	109	94-124	136
	Dioro	103	89-115	124

The gaps between estimates and reality are significantly wider than in Burkina Faso and Niger, probably because of a shorter data series, which only runs from 1993 to 2002. The ban on cereal exports, imposed by Burkina Faso, probably also increased market stress. If we had had access to earlier data, these estimates would probably be more accurate.

* Aberrant prices

5.2.3 Niger

The attempt to determine regressive equations to best estimate March prices on the sampled markets in Niger resulted in a model integrating the September price and the country's current year production, as well as that of Nigeria. The resulting equations are as follows:

For consumer markets (Niamey, Agadez, Tahoua):

$$px15 = 352 + 0{,}697\,px09 - 0{,}485\,pnNG - 1{,}22\,pnNGA \quad (5)$$

For production markets (Dosso, Maradi et Zinder):

$$px15 = 252 + 0{,}986\,px09 - 0{,}347\,pnNG - 0{,}941\,pnNGA \quad (6)$$

Applied to the 2002-2003 cropping season, these regressive equations yielded the following estimates for March 2003 prices:

Table 11: Price Estimates on Consumer and Production Markets in Niger for March 2003

Type	Market	Estimate	CI (95%)	Observed Values
Consumer	Agadez	168	151-186	NA
	Tahoua	160	144-177	NA
	Niamey	184	164-205	176
Production	Dosso	127	112-142	NA
	Maradi	131	115-147	130
	Zinder	164	142-186	130

At this point, the unavailability of observed prices on several markets (Agadez, Tahoua, and Dosso) for March 2003 makes it impossible to judge the quality of the estimates. For Niamey and Maradi, the maximum variation was 8 francs/kg; whereas in Zinder it reached 34 francs.

5.3 ANALYSIS OF MARCH PRICE ESTIMATES

A close study of the regressive equations indeed indicates that the coefficients relative to production levels are negative, reflecting the relation between supply and prices. The more significant the production, the lower the prices tend to be. In the extreme case, if production levels are very much higher than those observed and used in the regressive equations, mathematically, price estimates could completely founder. Under conditions of "surplus production crises," the results yielded by the equations will simply indicate what would be observed if industry actors did not react to counter the phenomenon's normal trend (for instance by stocking up, by delaying the marketing of products, by exporting much more than average, etc.). Conversely, an almost non-existent production would trigger such very high prices that other foodstuffs would become preferable to the local cereals, so that theoretical prices would never be reached. **As a result, mathematical results must be analysed in the light of social-economic reactions and the probable behaviour of actors, taking into account the information at their disposal.** The mathematical model only gives a theoretical indication of what can happen given habitual market behaviour. This kind of tool does not prevent the need for cross-checking and parallel analyses of the information and assumptions. Quite to the contrary, it only guides and supports it.

VI. PRACTICAL USE FOR DECISION-MAKING

History suggests that markets can be logically classified according to price levels in September and March, data for two consecutive cropping seasons, and to the production levels in neighbouring countries with significant ties of dependency. Indeed, PCA individuals – i.e. the 'market-year' couples – yield groupings which can be interpreted according to this basic logic, keeping in mind that any given year will never be perfectly identical to another, due primarily to the changing strategies of industry actors (producers and traders). However, knowing the factors influencing these various strategies, in 70 to 80% of the cases, enables one to anticipate them or, at least, to follow them closely.

Toward this end, scales measuring market stress levels were developed from the various groupings yielded by PCA. Scores were assigned to each of the variables linked to the principal components, according to whether they spread out or clustered the 'market-year' couples. New variables were calculated to build this scale.

6.1 CHOICE OF VARIABLES

The variables selected in order to develop the scale of market stress are as follows:

a. ***The impact of the current year (RPCS[30])*** *is measured through the production variation level (pl) in relation to the consumption standard (CS).* In Burkina, a yearly production decline of at least 10% in relation to the consumption standard triggers a slight price decrease or even an anticipated price increase before the month of March of the following year.

b. ***The consecutive production variation*** *(CPV) measures the residual impact of the preceding season's production on the following year, in relation to the expected results for the year (RPCS*). The scores assigned to CPV depend on the RPCS. For instance, the market reaction will vary if the production level decreases and if it is at or below the consumption standard.

c. ***The September price level (px09)*** *is indicative of the recent past of the market as well as, in part, the outlook for the ongoing cropping season.* ***The level of market stress after the lean period (PLMS****) measures how significant the seasonal price decrease will be, depending on the previous two indicators.* Indeed, combining the September price level with various production forecast indicators and the residual impact of the previous agricultural season will give rise to different strategies in each case.

d. ***The pre-lean period price indicator (LPI****) is represented by the price in March, a pivotal moment. If that price is high, market stress will be more significant.*

e. *Finally,* ***the third-country specific contribution (SC)*** *conveys the relative impact of that country's demand on the market.* This indicator plays a different, and more or less determining, role according to the country. In Niger, for example, the impact of Nigeria's production level and currency value are determining factors of the market trend. In Mali, any decrease in Mauritanian production affects that country's demand on the Malian market. If, in addition, the cropping season in Burkina is only acceptable, or even poor, the Malian market is the first resort, thus increasing stress on that market.

[30] RPCS: relation of production/consumption standard (RPNC in French); CPV: difference between production n and production n-1 (VSP in French); PLPI: post-hungry season period price indicator (IPS in French); SC: specific contribution of a third country (CS in French); PLMS: post-lean period market stress (NTPS in French).

As we can see, even if an attempt to simplify the market mechanism is made, the result remains a number of factor combinations where the effects must be analysed with special care. In order to facilitate and support this analysis at the level of the national and regional services, as well as at the level of the various analysis and consultation frameworks (especially national consultation and co-ordination systems, as well as regional systems closely monitoring the agricultural and food situation), the various parameters necessary for determining market conditions and anticipating market trends will be summarised and configured. This should facilitate collective analysis, and allow us to consider scenarios and hypotheses for market trends that will impact the food situation of the populations.

6.2 MEASUREMENT SCALE FOR CEREAL MARKET STRESS (SMS)

Assigning a coefficient or score to each of the variables defined above enables us to build a scale for measuring the market stress level (SMS), by summing these values. Two years may have the same value on the scale for different reasons. The impact on price levels may be the same but market analysis to support decision-making must distinguish among the various causes and the different possible strategies of industry actors. This means that projecting market trends requires an enlargement of the field of analysis – to verify the coherence between production statistics and the most likely probable trend, to consider the situation from a regional and international perspective, and, finally, to be free from constraining certainties, leaving room for doubt and questioning certain assumptions.

The scale is from 0 to 10:

0, 1, and 2 indicate an absence of market stress
3 and 4 indicate a risk of low stress
5 and 6 indicate a risk of moderate stress
7 and 8 indicate a risk of high stress
9 and 10 indicate a risk of very high stress

For the initial year, the scale (see below) was retrospectively rebuilt on the basis of real data. However, for the latest cropping seasons (2000/01, 2001/02, and 2002/03) it was built under the conditions for which it was devised, i.e. from forecast data produced in the month of November: production forecasts and calculations of March prices (pre-lean period).

6.2.1 Practical Use

The parameters determining the scale for each country were entered into MS Excel format containing macros for calculating the value of each parameter, which yielded the expected scale according to basic data (production forecasts for the upcoming year, final production levels for the preceding year, September prices). Simulations of possible variations between forecast data and final results can be generated using this programme.

Main Menu

Evaluation Grid for the Probable Cereal Market Stress Level for the Coming Year
(choose a country)

Burkina Faso | Mali | Niger

Input and Results Screen: 2004 Example (Burkina and Mali)

Label	Parameter	Value	Obs.
Provisional prod. BFA	PnBF	249	
Provisional prod. ML	PnML	238	*
Provisional prod. NE	PnNG		
Provisional prod. NGA	PnNGA		
Provisional prod. MAU	PnMAU	30,5	
Previous year's prod. BFA	Pn-1BFA	217	
Previous year's prod ML	Pn-1ML	141	
Previous year's prod NE	Pn-1NG		
Consumption Standard Mauritania	NC MAU	59	

Scores	Meaning
0-2	No stress
3-4	Weak stress
5-6	Moderate stress
7-8	Strong stress
9-10	Very strong stress

BURKINA FASO

Burkina Faso

Production markets			
Market	**Price Sept**	**Price March**	Observation
Dandé	113	18	
Djibasso	94	11	*
Léo	95	11	*
Pouytenga	95	11	*
Average	***99***	***13***	

Consumer markets		
Market	**Price Sept**	**Price March**
Bobo	150	47
Dori	120	35
Ouagadougou	123	36
Ouahigouya	138	42
Average	***133***	***40***

RPNC	31%	**0**
VSP	32	0
NTPS	116	**2**
IPPS	26	0
CS Mali	17%	0
Total		**2**
Conclusion		**No stress**

Average price September 2003	116
Average price March 2004	26
NC	190

*** Total price collapse under these conditions**

MALI

Mali

Production markets			
Market	**Price Sept**	**Price March**	**Observation**
Koutiala	125	-1	*
Dioro	112	-7	*
		-55	
Average	119	-4	

Consumer markets		
Market	**Price Sept**	**Price March**
Ségou	150	31
Gao	170	39
Bamako	183	44
	168	38

RPNC	17%	**0**
VSP	97	0
NTPS	143	**2**
IPPS	17	0
CS Mauritania	-48%	**2**
Total		**4**
Conclusion		**Weak stress**

*** Total price collapse under these conditions**

NC	204
Average March 2004	17

Moreover, **it can be configured so as to obtain a regional picture of probable national market trends depending on variations from one country or another**. The analysis can thus be carried out at the country or regional level, so as to provide an overall picture. These data can also be coupled with a geographical information system.

6.2.2 Niger

For the year 2003, we forecasted a moderately stressed Nigerien market, primarily due to three unfavorable indicators:

- The September 2002 price level (160 F/kg) with a 2 coefficient, since the high price level for 2002 was going to affect 2003 until a sufficiently significant supply offset this effect.
- The forecasted price level for March 2003 – which came in at 156 francs per kg, relatively high on average for the start of the lean period – forebodes even higher prices for the 2003 lean period. As a result, even though the 2003 lean period will experience lower prices than the previous one, these won't necessarily be affordable for many consumers, especially the poorest among them.
- The specific contribution of Nigeria, with a production decline of 10% in 2002/2003, should negatively impact supply on the Nigerien market.

As a result, despite good production levels in 2002/2003, any attempts at institutional purchases were potentially liable to aggravate market stress. It would be advisable to closely monitor the cereal flows with Nigeria in order to anticipate any changing trends.

Table 12: Market Stress Scale for Niger

NIGER	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
RPCS	2	0	2	2	2	0	0	2	0	0	
CPV	2	0	2	0	2	0	0	2	0	0	
PLMS	0	0	0	1	2	2	1	1	2	2	
LPI	0	0	0	1	2	0	1	2	2	2	
SC - Nigeria	1	1	1	1	1	1	1	2	2	2	
Total	5	1	5	5	9	3	3	9	6	6	
Market Stress Level	Moderate Stress	No Stress	Moderate Stress	Moderate Stress	Very High Stress	Low Stress	Low Stress	Very High Stress	Moderate Stress	Moderate Stress	

6.2.3 Mali

The various scales obtained for each year are developed in the chart below. From 2001 until 2003, the model predicts a highly stressed market with all indicators flashing red. Indeed, there was a significant decline in production levels in the 2000/2001 cropping season, from 179 kg/inhabitant to 127 kg/inhabitant (-29%). Since then, despite improving production levels – by 3% in 2001/2002 and 11% in 2002/2003 – prices have remained rather high. In 2002/2003, even with increases of 11 kg per inhabitant relative to the previous cropping season, production levels remained rather far from the consumption standard of 204 kg, running a 63 kg differential (34%). The average price level in September went from 153 CFA F/kg in 2001 to 180 F/kg in 2002. Yet the stress at the beginning of the lean period was lower, most probably because of the various strategies developed both by the authorities and by the consumers themselves. Consequently, the Malian cereal market should experience a high degree of stress in 2003. Mitigating effects on this market stress might include a good production in Burkina Faso. Paradoxically, the massive importation of maize from Northern Côte d'Ivoire, which could not be sold in the South of that country, had an unexpected softening effect on the high level of market stress.

Table 13: Market Stress Scale for Mali

MALI	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
RPCS	1	0	1	1	2	1	1	2	2	2	
CPV	1	0	0	0	2	0	1	2	2	2	
PLMS	2	0	2	2	2	2	2	2	2	2	
LPI	0	1	2	2	2	2	1	2	2	2	
SC - Mauritania	2	2	0	0	2	2	2	2	2	2	
Total	6	3	5	5	10	7	7	10	10	10	0
Market Stress Level	Moderate Stress	Low Stress	Moderate Stress	Moderate Stress	Very High Stress	High Stress	High Stress	Very High Stress	Very High Stress	Very High Stress	Low Stress

Again, these results demonstrate the relevance of an approach that leaves room for a dynamic analysis of the food situation in relation to various commercial strategies.

6.2.4 Burkina Faso

The application of the SMS scale to Burkina Faso data yields forecasts for the years since 1993. Looking at the past three years, it is clear that: i) in 2001, one should not have advised decision-makers to make a tender offer for the reconstitution of the NSS, since market conditions did not

allow for it – indeed, moderately stressed markets in 2000, followed by a significant decline in production levels relative to the consumption standard as well as to the previous year, could not be interpreted otherwise; ii) Malian production levels over the past few years have been significantly lower than the consumption standard, and Malian demand thus applied additional pressure on the Burkina market.

Table 14: Market Stress Scale in Burkina Faso

BFA	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
RPCS	0	0	1	2	1	2	1	1	2	0	0
CPV	0	0	0	2	0	2	1	0	2	0	0
PLMS	1	0	0	1	2	2	2	2	1	2	2
LPI	0	0	1	1	2	2	2	1	2	2	2
SC - Mali	2	1	0	1	2	2	1	1	2	2	2
Total	3	1	2	7	7	10	7	5	9	6	6
Market Stress Level	Low Stress	No Stress	No Stress	High Stress	High Stress	Very High Stress	High Stress	Moderate Stress	Very High Stress	Moderate Stress	Moderate Stress

Despite the last two good agricultural seasons (2001/2002 and 2002/2003), the Burkina market remained moderately stressed during the 2003 lean period. The causes of this stress are largely the same and require an examination of why prices remain at these thresholds despite such high production levels. This reveals a certain discrepancy, since 2001, between official production data and the perceptions of industry actors, as illustrated by maize imports from Ghana and Côte d'Ivoire, especially in 2002, when they began earlier than usual. In 2003, the temporary ban on cereal exports should have alleviated all market stress. Quite the contrary, prices on consumer markets during the lean period (from April to August) averaged 154 F/kg. This situation should provoke new questions.

VII. CONCLUSIONS

Given the objectives of this study, it is possible to organise the presentation of its results under four main subheadings:

7.1 IMPROVING THE KNOWLEDGE OF MARKET DYNAMICS IN AN ENLARGED AREA

This study has been made possible by the availability of series of data over a sufficiently long period, thanks to the existence of food security information systems that were developed in the Sahel in the aftermath of the major food crises and due to the needs of national and international decision-makers.

The use of data series over a long period sheds new light on market dynamics that complement the information gathered in surveys and from literature on this issue. It highlights the cumulative effect of a succession of cropping seasons on both price levels and price trends. It also highlights in a more systematic manner interrelations between the production outputs and markets of different countries of the region: those between Sahelian markets, as well as those between Sahelian countries and coastal countries of the Gulf of Guinea. Research in this area confirms that there is no longer a juxtaposition of national markets, but rather that we are currently witnessing the gradual integration of markets within a regional zone. This trend takes into account the concerns of authorities, as well as those of the actors and populations, to move toward the development of a thoroughly integrated economic and commercial zone that covers the entire West African region. This increasing market integration should be fostered as

market expansion constitutes one of the ways to regulate prices through more adequacies between supply and demand. This process sometimes worries decision-makers, due to the exports of food products in a context of uncertainty about future availability. From this perspective, the 2003/2004 cropping season, characterised by exceptional production levels and surpluses, will show to what extent the Sahel needs to be integrated into a wider area to be able to provide outlets that match the production capacities of its producers. This integration process is also needed during years of production crisis in order to transport cereals from the various West African production zones more easily.

7.2 Use of Methodology in Food Security Risk Analysis

Research conducted in the three countries added substantially to the body of information available to national and regional analysts, thus enabling them to refine their diagnoses of food risks. This study enabled the development of three simple tools for the analysis of market-related risks: **(i)** The use of **principal component analyses** has facilitated the systematisation of approaches as well as the graphic representation of a multi-criteria influence on the food situation (historical series); **(ii) March price predictions** upon the release of the first output estimates in October, with an acceptable degree of reliability to help anticipate difficult situations based on the precaution principle; **(iii) A scale of market stress** that takes account of the main parameters determining market change for any given country. **This scale constitutes a tool for dialogue on and analysis of market-related food insecurity risks that complements other available tools and approaches** and focuses on the risks linked to both the "availability" and "vulnerability – access" dimensions (monitoring of agricultural and weather conditions and all other early warning systems, agricultural survey/cereal balance sheets, market monitoring, vulnerability monitoring, etc.).

Two important aspects should be mentioned: (i) these tools are experimental and should be tested by users, criticised and improved on a case by case basis, since they have been developed to take into account as much as possible the real characteristics of food markets and economies in each country. Any information and analysis enabling to build upon this knowledge makes it possible to refine tools and to improve their relevance and usefulness; (ii) every year enriches databases and therefore offers the opportunity to enlarge the range of situations that are taken into account in the historical analysis (actors' response in face of given characteristics) and to adjust models so that they become more and more refined over time. Thus, the suggested tools are not ready-to-use tools. They should be regularly checked and updated. To this end, strong co-operation between the users of these tools, information systems and researchers should be constantly sought out.

7.3 Functional Integration of Regional Dynamics into Diagnoses, Analyses, and Decision-Making Processes

The tools developed within the framework of this study will substantially improve the decision-making process, as they enable a more systematic incorporation of regional data into diagnoses and analyses normally carried out on the national level. Yet, these tools offer even more than this. They also integrate parameters from neighbouring countries in order to better understand the evolution of market stress in a given country, and thereby identify its food insecurity risks. From this perspective, they open up new opportunities for dialogue and regional co-operation in the area of food crisis prevention. The availability of analytical and decision-making tools on the regional level will become even more important in the future as markets will play a greater role in the management of food security (given the combined effect of urbanisation and integration) and public policy co-ordination will become a key element of the credibility and efficiency of national and regional food security strategies. Finally, these tools allow the institutions responsible for food security management to think through and formulate adequate responses to crises by

enriching the ongoing debate on the probable impact of various types of national and regional actions on market workings and prices. Provisional analyses of market stress should more informed choices of the most adequate instruments to cope with various crises to be made (food aid volume, localisation, and modes of distribution—gift, subsidised sale, food for work, cash for work, etc.—reinforcement of decentralised stocking strategies via cereal banks and other means of village stocking; more or less massive recourse to importations for stabilising or lowering prices, etc.). Similarly, these tools should arouse a great deal of interest among managers of national security stock (choice of the NSS replenishment or technical rotation period; choice of the manner of technical rotation for their NSSs; choice of procurement or marketing zones on the local or regional market; etc.).

As a general rule, food security managers have access to tools that enable them to better anticipate serious crises and to adapt their interventions accordingly. One can also assume that price trends during exceptional years (such as the current 2003/2004 cropping season) do not come as a surprise. Although difficult to manage, the situation can easily be anticipated. However, decision-making needs are most crucial during intermediary years, when trends result from complex interplay of qualitative and quantitative factors, on the one hand, and spatial and temporal ones, on the other, thus making them very difficult to decipher. These are the most common kinds of years. Food security managers and officials are forced to anticipate the lean period in order to prepare their interventions early enough so that they are operational upon the start of the lean period for households. This type of tool should help them to contextualise their interventions, as well as to enhance their analyses of food risks and their assessments of the probable consequences their interventions will bring.

By cultivating the use of such tools, which bring together national and regional data based on the actual workings of food economies in the region, food security managers in Sahelian countries will effectively multiply the opportunities on the *regional map* for finding and deploying solutions to food crises. Under these conditions, food crisis prevention and management strategy, in itself, serves as a vector of regional integration. The response entails not only integration within the Sahel itself, but also the integration of the Sahel with the West African coastal markets, a situation this study demonstrates by more precisely measuring the impact of Nigerian, Ghanian, and Ivorian production and trade on the food economies of Sahelian countries.

7.4 Contribution to the Development of Market Regional Information Systems

This study illustrated the importance of making rapid progress towards the establishment of a regional market information system. Using national MIS will help contribute to the crucial task of identifying markets that are truly important for the regional food economy, and which should therefore be the object of harmonised monitoring efforts (in terms of data collection and processing methods) so as to allow for data comparison. Price monitoring should be paralleled by close observation of cross-border flows. Methodologically, the development of price analyses makes the pinpointing of possible inconsistencies possible, especially those arising between production monitoring and market tracking procedures. By serving as an “inconsistency locator,” these analyses can facilitate data verification and the qualitative monitoring of information systems (identification of aberrant price monitoring data, or inconsistencies between production data).

VIII. PERSPECTIVES

First launched in three countries on an experimental basis, this study should now be applied to all of the countries of the CILSS zone and intensified as part of a research-action project.

To this end, it should be integrated into the work programmes of specialised institutions of the CILSS—particularly the Sahel Institute of the Agrhymet Centre and the PREGEC—in a manner that allows it to develop within the framework of an ongoing dialogue between information system managers, researchers, analysts, and the users of the decision-making tools for whom this study is mostly intended. Originally conceived through a combination of field-level knowledge with statistical approaches, the tools presented in this study should be progressively fine-tuned and improved by continuing to rely on this combination, as well as by drawing upon feedback regarding problems encountered by their users. Such feedback should be increasingly forthcoming, as this study could soon be made available to countries seeking to employ such tools. These are far from highly sophisticated tools demanding considerable means to be able to be used. However, their increased use can only be beneficial from the perspective of building collective capacities to assess food situations, open dialogues, facilitate joint actions, and contribute to decision-making processes. A management training programme to accompany the transfer of these tools should thus be designed with these considerations in mind.

ANNEXES

Annex 1: Summary of the Conclusions of the Network 2002 Annual Meeting

Annex 2: Statistical Annexes

ANNEX 1: SUMMARY OF THE CONCLUSIONS OF THE NETWORK 2002 ANNUAL MEETING

Synthesis of available knowledge on the determining factors in the rapid rise in cereal prices

The study carried out in 2002 exposed that cereal market trends resulted from the interplay of a set of quantitative and qualitative factors:

a. On the quantitative level, the cereal market conditions and price trends are determined by the cumulative effects of crop performance in two consecutive cropping seasons;
b. Added to these quantitative factors are various qualitative factors tied to the behaviour of direct (commercial traders, farmers) or institutional (governments, NGOs) actors in this sector, easing or exacerbating conditions on cereal markets ;
c. Beyond this, the sub-regional market has an increasingly important influence on food security conditions at the national or sub-national level. The juxtaposition of domestic markets operations and sub-regional trade restricted to occasional exports of disposable surpluses is giving way to increasingly integrated sub-regional markets including the coastal states, in which trading is conducted based on opportunities for business dealings by commercial operators;
d. Consumers adapt their behaviour to respond to price trends. To cope with rising prices, they seek to diversify the types of cereals they consume. This generally translates into a higher consumption of rice, including in rural areas.

However, there are still a number of uncertainties, particularly with respect to:

- The ability of farmers to influence market conditions;
- The impact of income generated by sales of cash crops on farmer strategies;
- Ties between movements in cereal prices and prices for other basic consumer products;
- The weight of each of these factors or determinants in driving the market.

The presentation of these results during the annual meeting of the Sahelian Food Crisis Prevention and Management Network in December 2002[31], was followed by a very rich debate that helped to confirm the importance of this issue for network members.

The debate focused extensively on the behaviour and strategies of the actors of this sector: private operators and institutional stakeholders. Discussions confirmed that **market actors primarily position themselves, on one hand, according to their interests and, on the other hand, based on their own personal analysis of the supply situation and of market conditions**. Thus, the quality of the data produced by information networks is crucial in narrowing the gap between how market actors perceive different situations, which mostly determines their behaviour (particularly in regard to the cropping season results) and actual conditions. Likewise, the provision of information specifically designed to meet the needs of different types of actors and of farmers in particular is essential to reduce inequities in access to market information and restore the balance of power between farmers and traders in their business dealings.

[31] Brussels – December 9-11, 2002.

The current escalation in local cereal prices has conflicting effects. Over the long-term, it can help boost farmer income and, in this way, play an important role in increasing the production of food crops on a commercial scale and financing the modernisation of farming systems. This is exactly what is happening with rice farming in high agro-ecological potential, food-secure production zones. On the other hand, this price escalation can harm farmers in food insecure areas with net structural food deficits who are forced to buy provisions on area markets to supplement on-farm production to meet their year-round food needs.

As far as urban consumers are concerned, the effects of steep price increases vary according to household income and coping ability. They could force certain households to cut back on their cereal consumption, heighten food insecurity problems and foster the replacement of cereal by rice.

Thus, another important factor at play has to do with the modernisation and adaptive capacity of this sector within the Sahelian region. From the production dynamics standpoint, price increases are of interest only if their main beneficiaries are farmers. From the food security standpoint, these higher prices should not heighten food access problems. Thus, rollbacks in transaction costs, markets driven by players operating in an openly competitive climate, the implementation of measures designed to prevent speculative practices and the promotion of cereal processing enterprises are all possible approaches to reconciling farmer and consumer interests.

Main recommendations

The meeting of the Sahelian Food Crisis Prevention and Management Network highlighted five recommendations that it is useful to recall here. These involve:

i. *Better understanding the workings of sub-regional markets and their actors*. The current store of sub-regional information dates back more than 10 years and any updates have been piecemeal at best and, in many cases, confined to the individual country level. Thus, there is a compelling need for additional research to build a store of up-to-date sub-regional information on actor organisation and strategies, the interconnection of markets in Sahelian countries and coastal states, the interdependence of different sectors or industries, the distribution of profit margins in the different industries, the impact of government policies, etc.

ii. Better understanding its impact on consumers and the conditions affecting food access and household coping strategies, particularly for low-income households. These studies could draw on the regular research efforts of early warning system networks, vulnerability assessment systems and poverty watch groups.

iii. Exploring the opportunities afforded by the more systematic use of price data in examining food security conditions and risks, with emphasis on fine-tuning studies of historical price series, correlations between production and price levels, the extent of sub-regional market integration, etc.

iv. Developing regional price information systems, drawing on country-level Market Information Systems and ongoing initiatives. The regionalisation of trade dynamics requires access to information better attuned to this new phenomenon: understanding of major cross-border flows (prices and volumes) so as to provide institutional players with basic information better reflecting the regional dimensions of food security problems at the country level;

v. Better identification of the needs of national food crisis management networks for decision-making tools. The contrasting effects of current price trends on grain farmers and consumers in particular will ultimately cause government agencies to resort to arbitration between, assessment of trade offs and to reflect on the impact of government intervention on markets and on the food security status of different socio-economic groups in consultation with corresponding actors. This, in turn, requires better consolidation of quantitative and qualitative data (production, vulnerability, price data, etc.) and the availability of reliable forecasting tools to identify food security risks and successfully manage such risks using appropriate crisis management mechanisms.

Multiple Regressions

Niger

Consumer markets

Regression Analysis: px15 versus px09; pn; pnNGA

The regression equation is
px15 = 352 + 0,697 px09 - 0,485 pn - 1,22 pnNGA

Predictor	Coef	SE Coef	T	P	VIF
Constant	351,78	75,87	4,64	0,000	
px09	0,6968	0,1099	6,34	0,000	1,5
pn	-0,4853	0,1009	-4,81	0,000	1,0
pnNGA	-1,2237	0,3648	-3,35	0,002	1,5

S = 21,57 R-Sq = 78,2% R-Sq(adj) = 76,2%
PRESS = 19633,4 R-Sq(pred) = 71,30%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	53520	17840	38,36	0,000
Residual Error	32	14883	465		
Lack of Fit	29	14578	503	4,95	0,106
Pure Error	3	305	102		
Total	35	68403			

30 rows with no replicates

Source	DF	Seq SS
px09	1	38792
pn	1	9495
pnNGA	1	5232

Obs	px09	px15	Fit	SE Fit	Residual	St Resid
1	74	87,00	114,70	7,45	-27,70	-1,37
2	90	57,00	84,39	6,39	-27,39	-1,33
3	88	79,00	86,33	4,88	-7,33	-0,35
4	64	83,00	91,90	6,47	-8,90	-0,43
5	85	82,00	71,79	5,97	10,21	0,49
6	88	102,00	78,86	7,67	23,14	1,15
7	145	143,00	134,76	6,07	8,24	0,40
8	175	176,00	187,01	10,02	-11,01	-0,58
9	193	109,00	152,28	9,67	-43,28	-2,25R
10	118	118,00	109,00	4,80	9,00	0,43
11	140	178,00	173,98	7,70	4,02	0,20
12	198	184,00	191,21	9,70	-7,21	-0,37
13	74	83,00	114,70	7,45	-31,70	-1,57
14	74	70,00	73,24	7,52	-3,24	-0,16
15	80	70,00	80,75	5,36	-10,75	-0,51
16	64	75,00	91,90	6,47	-16,90	-0,82
17	69	66,00	60,64	6,59	5,36	0,26
18	74	92,00	69,10	7,50	22,90	1,13
19	117	145,00	115,25	4,28	29,75	1,41
20	136	194,00	159,84	7,44	34,16	1,69
21	158	108,00	127,89	7,03	-19,89	-0,98

22	104	119,00	99,25	5,23	19,75	0,94
23	122	180,00	161,43	8,02	18,57	0,93
24	143	185,00	152,88	9,54	32,12	1,66
25	88	92,00	124,45	6,80	-32,45	-1,59
26	90	80,00	84,39	6,39	-4,39	-0,21
27	104	82,00	97,48	4,31	-15,48	-0,73
28	82	88,00	104,45	5,45	-16,45	-0,79
29	97	85,00	80,15	5,81	4,85	0,23
30	82	104,00	74,68	7,56	29,32	1,45
31	139	148,00	130,58	5,60	17,42	0,84
32	177	180,00	188,41	10,18	-8,41	-0,44
33	182	121,00	144,61	8,75	-23,61	-1,20
34	120	120,00	110,40	4,78	9,60	0,46
35	128	185,00	165,62	7,86	19,38	0,97
36	183	199,00	180,75	9,28	18,25	0,94

R denotes an observation with a large standardized residual

Durbin-Watson statistic = 1,40

Predicted Values for New Observations

New Obs	Fit	SE Fit	95,0% CI	95,0% PI
1	168,10	8,58	(150,63; 185,57)	(120,82; 215,37)
2	160,43	8,09	(143,96; 176,90)	(113,52; 207,35)
3	184,12	10,00	(163,75; 204,50)	(135,70; 232,55)

Values of Predictors for New Observations

New Obs	px09	pn	pnNGA
1	189	254	157
2	178	254	157
3	212	254	157

Lack of fit test
Possible curvature in variable px09 (P-Value = 0,000)
Possible interactions with variable px09 (P-Value = 0,000)
Possible curvature in variable pn (P-Value = 0,006)
Possible curvature in variable pnNGA (P-Value = 0,001)
Possible interactions with variable pnNGA (P-Value = 0,006)
Overall lack of fit test is significant at P = 0,000

Production markets

Regression Analysis: px15 versus px09; pn; pnNGA

The regression equation is
px15 = 252 + 0,986 px09 - 0,347 pn - 0,941 pnNGA

35 cases used 1 cases contain missing values

Predictor	Coef	SE Coef	T	P	VIF
Constant	252,34	77,82	3,24	0,003	
px09	0,9860	0,1535	6,42	0,000	1,6
pn	-0,34723	0,09764	-3,56	0,001	1,1
pnNGA	-0,9412	0,3614	-2,60	0,014	1,7

S = 20,14 R-Sq = 79,4% R-Sq(adj) = 77,4%
PRESS = 18556,1 R-Sq(pred) = 69,62%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	48505	16168	39,84	0,000
Residual Error	31	12580	406		
Lack of Fit	29	12557	433	38,49	0,026
Pure Error	2	23	11		
Total	34	61085			

31 rows with no replicates

Source	DF	Seq SS
px09	1	41967
pn	1	3786
pnNGA	1	2752

Obs	px09	px15	Fit	SE Fit	Residual	St Resid
1	58	*	91,45	6,95	*	*
2	63	58,00	66,91	5,24	-8,91	-0,46
3	52	57,00	58,06	4,61	-1,06	-0,05
4	41	60,00	63,04	6,45	-3,04	-0,16
5	48	62,00	44,75	5,57	17,25	0,89
6	61	66,00	60,41	7,54	5,59	0,30
7	102	129,00	113,46	6,71	15,54	0,82
8	128	181,00	161,86	10,19	19,14	1,10
9	93	107,00	93,72	6,31	13,28	0,69
10	72	104,00	79,51	4,49	24,49	1,25
11	117	133,00	160,32	7,72	-27,32	-1,47
12	111	165,00	138,47	8,53	26,53	1,45
13	45	56,00	78,64	8,00	-22,64	-1,22
14	41	44,00	45,22	7,09	-1,22	-0,06
15	44	46,00	50,17	5,33	-4,17	-0,21
16	42	50,00	64,03	6,35	-14,03	-0,73
17	44	39,00	40,81	5,74	-1,81	-0,09
18	45	63,00	44,63	7,05	18,37	0,97
19	74	104,00	85,86	4,01	18,14	0,92
20	98	140,00	132,28	7,33	7,72	0,41
21	105	68,00	105,55	7,38	-37,55	-2,00R
22	68	90,00	75,56	4,62	14,44	0,74
23	94	145,00	137,64	7,46	7,36	0,39
24	109	148,00	136,49	8,53	11,51	0,63
25	51	60,00	84,55	7,47	-24,55	-1,31
26	54	42,00	58,04	5,83	-16,04	-0,83
27	48	49,00	54,12	4,95	-5,12	-0,26
28	48	47,00	69,94	5,80	-22,94	-1,19
29	50	48,00	46,72	5,51	1,28	0,07
30	56	69,00	55,48	7,30	13,52	0,72
31	87	109,00	98,67	4,99	10,33	0,53
32	98	137,00	132,28	7,33	4,72	0,25
33	129	65,00	129,21	10,19	-64,21	-3,70R
34	68	84,00	75,56	4,62	8,44	0,43
35	95	147,00	138,63	7,43	8,37	0,45
36	116	152,00	143,40	8,57	8,60	0,47

R denotes an observation with a large standardized residual

Durbin-Watson statistic = 2,19

Predicted Values for New Observations

New Obs	Fit	SE Fit	95,0% CI	95,0% PI
1	126,81	7,50	(111,51; 142,12)	(82,97; 170,66)
2	130,76	7,72	(115,01; 146,51)	(86,76; 174,76)
3	164,28	10,88	(142,10; 186,46)	(117,59; 210,97)

Values of Predictors for New Observations

New Obs	px09	pn	pnNGA
1	112	254	157
2	116	254	157
3	150	254	157

Lack of fit test
Possible interactions with variable px09 (P-Value = 0,089)
Possible interactions with variable pn (P-Value = 0,020)
Possible curvature in variable pnNGA (P-Value = 0,092)
Possible interactions with variable pnNGA (P-Value = 0,000)
Possible lack of fit at outer X-values (P-Value = 0,001)
Overall lack of fit test is significant at P = 0,000

Regression Analysis: px15 versus px09; pnBF; pnML

The regression equation is
px15 = 281 + 0,406 px09 - 0,715 pnBF - 0,492 pnML

Predictor	Coef	SE Coef	T	P	VIF
Constant	281,36	35,26	7,98	0,000	
px09	0,40554	0,08169	4,96	0,000	1,3
pnBF	-0,7147	0,1462	-4,89	0,000	1,2
pnML	-0,4922	0,1758	-2,80	0,008	1,4

S = 19,01 R-Sq = 73,6% R-Sq(adj) = 71,4%
PRESS = 16481,1 R-Sq(pred) = 66,49%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	36181	12060	33,38	0,000
Residual Error	36	13007	361		
Total	39	49188			

No replicates. Cannot do pure error test.

Source	DF	Seq SS
px09	1	18628
pnBF	1	14722
pnML	1	2831

Obs	px09	px15	Fit	SE Fit	Residual	St Resid
1	79	66,00	89,18	7,77	-23,18	-1,34
2	78	69,00	71,05	5,49	-2,05	-0,11
3	75	75,00	71,03	6,21	3,97	0,22
4	102	113,00	112,47	3,75	0,53	0,03
5	162	125,00	138,69	4,15	-13,69	-0,74
6	122	145,00	154,01	6,59	-9,01	-0,51
7	198	133,00	143,14	6,83	-10,14	-0,57
8	128	97,00	104,37	5,37	-7,37	-0,40
9	111	148,00	148,80	6,48	-0,80	-0,04
10	170	173,00	131,23	6,68	41,77	2,35R
11	89	58,00	93,23	7,24	-35,23	-2,00R
12	67	70,00	66,59	5,95	3,41	0,19
13	74	78,00	70,63	6,23	7,37	0,41
14	101	112,00	112,06	3,77	-0,06	-0,00
15	165	105,00	139,91	4,31	-34,91	-1,89
16	104	134,00	146,71	6,81	-12,71	-0,72
17	169	108,00	131,38	4,83	-23,38	-1,27
18	105	88,00	95,04	4,85	-7,04	-0,38
19	97	144,00	143,12	6,99	0,88	0,05
20	167	151,00	130,01	6,63	20,99	1,18
21	93	72,00	94,86	7,04	-22,86	-1,29
22	75	76,00	69,84	5,61	6,16	0,34
23	81	85,00	73,46	6,13	11,54	0,64
24	99	143,00	111,25	3,82	31,75	1,71
25	194	124,00	151,67	6,14	-27,67	-1,54
26	125	162,00	155,23	6,59	6,77	0,38
27	208	135,00	147,20	7,57	-12,20	-0,70
28	130	111,00	105,18	5,44	5,82	0,32
29	126	195,00	154,88	6,12	40,12	2,23R
30	209	176,00	147,04	7,98	28,96	1,68
31	92	82,00	94,45	7,09	-12,45	-0,71
32	82	71,00	72,68	5,35	-1,68	-0,09
33	82	93,00	73,87	6,12	19,13	1,06

34	107	123,00	114,50	3,66	8,50	0,46
35	171	131,00	142,34	4,65	-11,34	-0,62
36	132	150,00	158,06	6,61	-8,06	-0,45
37	125	125,00	113,54	3,08	11,46	0,61
38	125	101,00	103,15	5,26	-2,15	-0,12
39	105	155,00	146,37	6,68	8,63	0,49
40	196	162,00	141,77	7,42	20,23	1,16

R denotes an observation with a large standardized residual

Durbin-Watson statistic = 2,01

Predicted Values for New Observations

New Obs	Fit	SE Fit	95,0% CI	95,0% PI
1	138,50	6,75	(124,82; 152,19)	(97,60; 179,41)
2	136,07	6,43	(123,02; 149,11)	(95,37; 176,77)
3	149,86	8,44	(132,74; 166,98)	(107,68; 192,04)
4	135,66	6,38	(122,72; 148,61)	(95,00; 176,33)

Values of Predictors for New Observations

New Obs	px09	pnBF	pnML
1	196	214	141
2	190	214	141
3	224	214	141
4	189	214	141

Lack of fit test
Possible interactions with variable px09 (P-Value = 0,000)
Possible interactions with variable pnBF (P-Value = 0,020)
Possible curvature in variable pnML (P-Value = 0,000)
Possible interactions with variable pnML (P-Value = 0,003)
Possible lack of fit at outer X-values (P-Value = 0,001)
Overall lack of fit test is significant at P = 0,000

Production markets

Regression Analysis: px15 versus px09; pnBF; pnML

The regression equation is
px15 = 274 + 0,405 px09 - 0,779 pnBF - 0,452 pnML

35 cases used 5 cases contain missing values

Predictor	Coef	SE Coef	T	P	VIF
Constant	273,96	35,91	7,63	0,000	
px09	0,40530	0,08311	4,88	0,000	1,2
pnBF	-0,7790	0,1650	-4,72	0,000	1,2
pnML	-0,4517	0,1859	-2,43	0,021	1,4

S = 19,32 R-Sq = 74,4% R-Sq(adj) = 71,9%
PRESS = 15327,8 R-Sq(pred) = 66,13%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	33683	11228	30,06	0,000
Residual Error	31	11577	373		
Lack of Fit	30	11564	385	28,51	0,147
Pure Error	1	14	14		
Total	34	45260			

33 rows with no replicates

Source	DF	Seq SS
px09	1	16693
pnBF	1	14786
pnML	1	2205

Obs	px09	px15	Fit	SE Fit	Residual	St Resid
1	48	36,00	60,81	8,60	-24,81	-1,43
2	48	42,00	44,55	6,05	-2,55	-0,14
3	40	46,00	43,88	6,90	2,12	0,12
4	61	76,00	83,08	4,63	-7,08	-0,38
5	120	77,00	107,86	3,79	-30,86	-1,63
6	66	102,00	119,85	7,79	-17,85	-1,01
7	129	81,00	101,21	4,23	-20,21	-1,07
8	67	56,00	66,80	5,22	-10,80	-0,58
9	63	108,00	116,71	7,74	-8,71	-0,49
10	128	111,00	98,08	7,55	12,92	0,73
11	69	58,00	69,32	7,58	-11,32	-0,64
12	62	49,00	50,23	5,55	-1,23	-0,07
13	60	64,00	51,99	6,49	12,01	0,66
14	115	97,00	104,97	4,38	-7,97	-0,42
15	154	93,00	121,64	5,46	-28,64	-1,55
16	100	*	133,63	7,22	*	*
17	*	*	*	*	*	*
18	*	63,00	*	*	*	*
19	75	104,00	121,58	7,23	-17,58	-0,98
20	146	*	105,37	7,78	*	*
21	*	53,00	*	*	*	*
22	58	44,00	48,60	5,68	-4,60	-0,25
23	53	69,00	49,15	6,59	19,85	1,09
24	89	109,00	94,43	3,91	14,57	0,77
25	161	113,00	124,48	5,91	-11,48	-0,62
26	128	161,00	144,98	7,55	16,02	0,90
27	186	128,00	124,32	8,04	3,68	0,21
28	135	76,00	94,36	7,01	-18,36	-1,02
29	87	138,00	126,44	6,84	11,56	0,64
30	164	140,00	112,67	8,28	27,33	1,57
31	69	52,80	69,32	7,58	-16,52	-0,93
32	55	57,50	47,51	5,77	9,99	0,54
33	57	82,00	50,77	6,53	31,23	1,72
34	81	98,30	91,19	3,99	7,11	0,38
35	146	123,00	118,40	4,97	4,60	0,25
36	113	157,00	138,90	7,28	18,10	1,01
37	187	107,00	124,72	8,12	-17,72	-1,01
38	96	69,00	78,56	5,37	-9,56	-0,51
39	82	158,00	124,41	6,99	33,59	1,86
40	152	151,00	107,81	7,92	43,19	2,45R

R denotes an observation with a large standardized residual

Durbin-Watson statistic = 1,29

Predicted Values for New Observations

New Obs	Fit	SE Fit	95,0% CI	95,0% PI
1	101,12	6,29	(88,28; 113,96)	(59,67; 142,57)
2	108,01	6,96	(93,81; 122,21)	(66,12; 149,90)
3	117,74	8,23	(100,95; 134,52)	(74,90; 160,58)
4	109,23	7,10	(94,74; 123,71)	(67,24; 151,22)

Values of Predictors for New Observations

New Obs	px09	pnBF	pnML
1	142	214	141
2	159	214	141
3	183	214	141
4	162	214	141

```
Lack of fit test
Possible interactions with variable px09 (P-Value = 0,027)
Possible curvature in variable pnML (P-Value = 0,011)
Overall lack of fit test is significant at P = 0,011
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Mali

Consumer markets

Regression Analysis: px15 versus px09; pnML; pnMAU

The regression equation is
px15 = 197 + 0,417 px09 - 1,06 pnML + 0,765 pnMAU

Predictor	Coef	SE Coef	T	P	VIF
Constant	197,19	28,23	6,99	0,000	
px09	0,41680	0,08216	5,07	0,000	1,5
pnML	-1,0557	0,1788	-5,91	0,000	1,8
pnMAU	0,7654	0,3008	2,54	0,018	2,2

S = 14,58 R-Sq = 79,8% R-Sq(adj) = 77,2%
PRESS = 6500,53 R-Sq(pred) = 73,17%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	19333,7	6444,6	30,30	0,000
Residual Error	23	4891,7	212,7		
Lack of Fit	22	4851,2	220,5	5,44	0,328
Pure Error	1	40,5	40,5		
Total	26	24225,4			

25 rows with no replicates

Source	DF	Seq SS
px09	1	11748,4
pnML	1	6208,0
pnMAU	1	1377,3

Obs	px09	px15	Fit	SE Fit	Residual	St Resid
1	67	53,00	70,99	5,26	-17,99	-1,32
2	57	57,00	63,23	5,95	-6,23	-0,47
3	93	104,00	112,97	6,93	-8,97	-0,70
4	158	105,00	123,46	4,47	-18,46	-1,33
5	91	101,00	105,69	5,53	-4,69	-0,35
6	158	100,00	123,14	3,89	-23,14	-1,65
7	87	61,00	70,51	5,80	-9,51	-0,71
8	62	103,00	113,45	7,77	-10,45	-0,85
9	158	148,00	140,35	4,66	7,65	0,55
10	91	82,00	80,99	4,21	1,01	0,07
11	78	93,00	71,98	5,62	21,02	1,56
12	128	125,00	127,55	7,95	-2,55	-0,21
13	206	125,00	143,46	6,44	-18,46	-1,41
14	110	127,00	113,61	4,49	13,39	0,96
15	173	121,00	129,39	4,77	-8,39	-0,61
16	112	100,00	80,93	5,19	19,07	1,40
17	95	130,00	127,21	6,13	2,79	0,21
18	175	175,00	147,43	5,03	27,57	2,01R
19	87	75,00	79,32	4,34	-4,32	-0,31
20	78	84,00	71,98	5,62	12,02	0,89
21	113	124,00	121,30	7,39	2,70	0,21
22	183	125,00	133,88	5,22	-8,88	-0,65
23	112	119,00	114,45	4,40	4,55	0,33
24	184	130,00	133,98	5,51	-3,98	-0,29
25	126	99,00	86,76	5,19	12,24	0,90
26	99	125,00	128,87	5,98	-3,87	-0,29
27	179	175,00	149,10	5,17	25,90	1,90

R denotes an observation with a large standardized residual

Durbin-Watson statistic = 1,80

Predicted Values for New Observations

New Obs	Fit	SE Fit	95,0% CI	95,0% PI
1	132,97	5,83	(120,91; 145,02)	(100,48; 165,45)
2	140,88	6,44	(127,56; 154,20)	(107,91; 173,86)
3	145,05	6,88	(130,81; 159,29)	(111,69; 178,41)

Values of Predictors for New Observations

New Obs	px09	pnML	pnMAU
1	181	141	12,0
2	200	141	12,0
3	210	141	12,0

Lack of fit test
Possible curvature in variable pnML (P-Value = 0,009)
Overall lack of fit test is significant at P = 0,009

Production markets

Regression Analysis: px15 versus px09; pnML; pnMAU

The regression equation is
px15 = 186 + 0,429 px09 - 1,10 pnML + 0,692 pnMAU

Predictor	Coef	SE Coef	T	P	VIF
Constant	185,88	24,00	7,75	0,000	
px09	0,42875	0,08918	4,81	0,000	1,4
pnML	-1,0971	0,1613	-6,80	0,000	1,8
pnMAU	0,6918	0,2658	2,60	0,021	2,1

S = 10,76 R-Sq = 87,7% R-Sq(adj) = 85,1%
PRESS = 2637,13 R-Sq(pred) = 80,02%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	3	11576,1	3858,7	33,36	0,000
Residual Error	14	1619,5	115,7		
Total	17	13195,6			

No replicates. Cannot do pure error test.

Source	DF	Seq SS
px09	1	5908,9
pnML	1	4883,5
pnMAU	1	783,7

Obs	px09	px15	Fit	SE Fit	Residual	St Resid
1	54	41,00	44,71	3,92	-3,71	-0,37
2	48	50,00	36,75	5,08	13,25	1,40
3	88	87,00	89,58	7,07	-2,58	-0,32
4	133	84,00	95,87	4,89	-11,87	-1,24
5	71	91,00	79,33	3,98	11,67	1,17
6	138	94,00	96,44	5,39	-2,44	-0,26
7	86	48,00	49,89	4,69	-1,89	-0,19
8	55	87,00	92,26	5,65	-5,26	-0,58
9	131	131,00	112,56	4,90	18,44	1,93
10	53	36,00	44,28	3,96	-8,28	-0,83
11	38	38,00	32,46	5,22	5,54	0,59
12	63	79,00	78,86	6,28	0,14	0,02
13	111	77,00	86,43	4,07	-9,43	-0,95
14	53	81,00	71,61	5,04	9,39	0,99
15	112	74,00	85,29	3,57	-11,29	-1,11

16	54	36,00	36,17	5,20	-0,17	-0,02
17	41	72,00	86,26	6,37	-14,26	-1,64
18	121	121,00	108,28	4,50	12,72	1,30

Durbin-Watson statistic = 2,97

No evidence of lack of fit (P > 0,1)

Principal Component Analysis

Niger

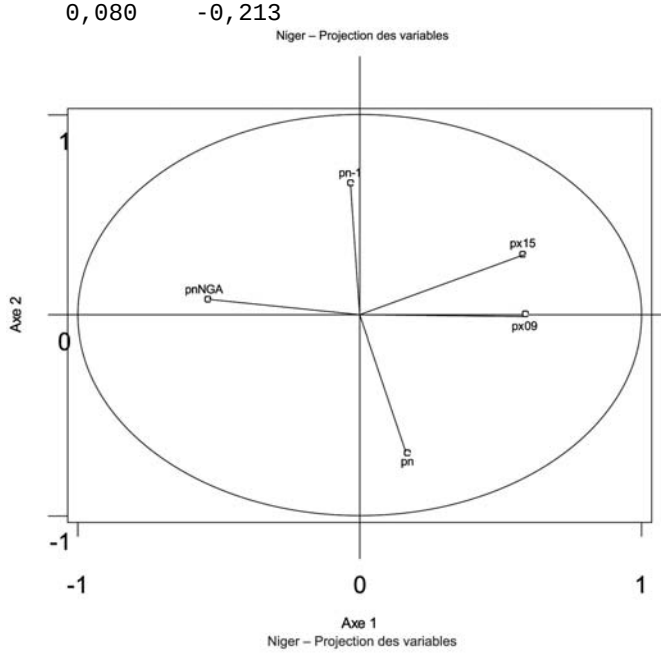
Principal Component Analysis: px09; px15; pn; pn-1; pnNGA

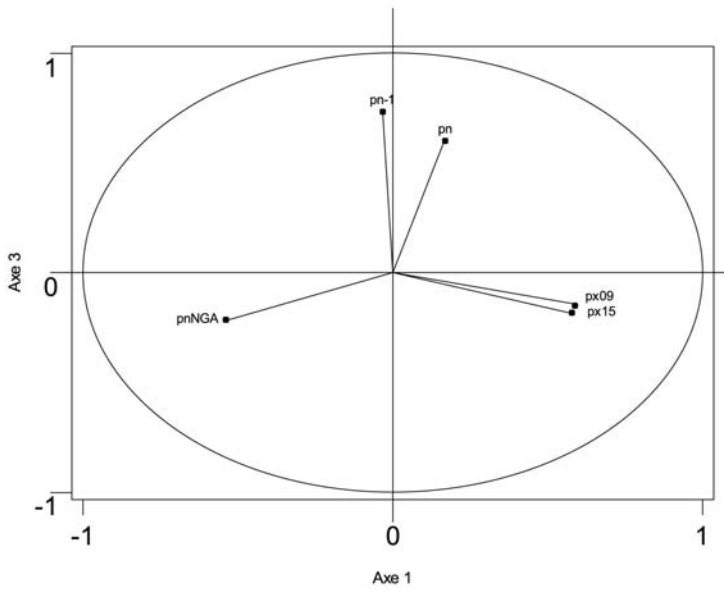
Eigenanalysis of the Correlation Matrix

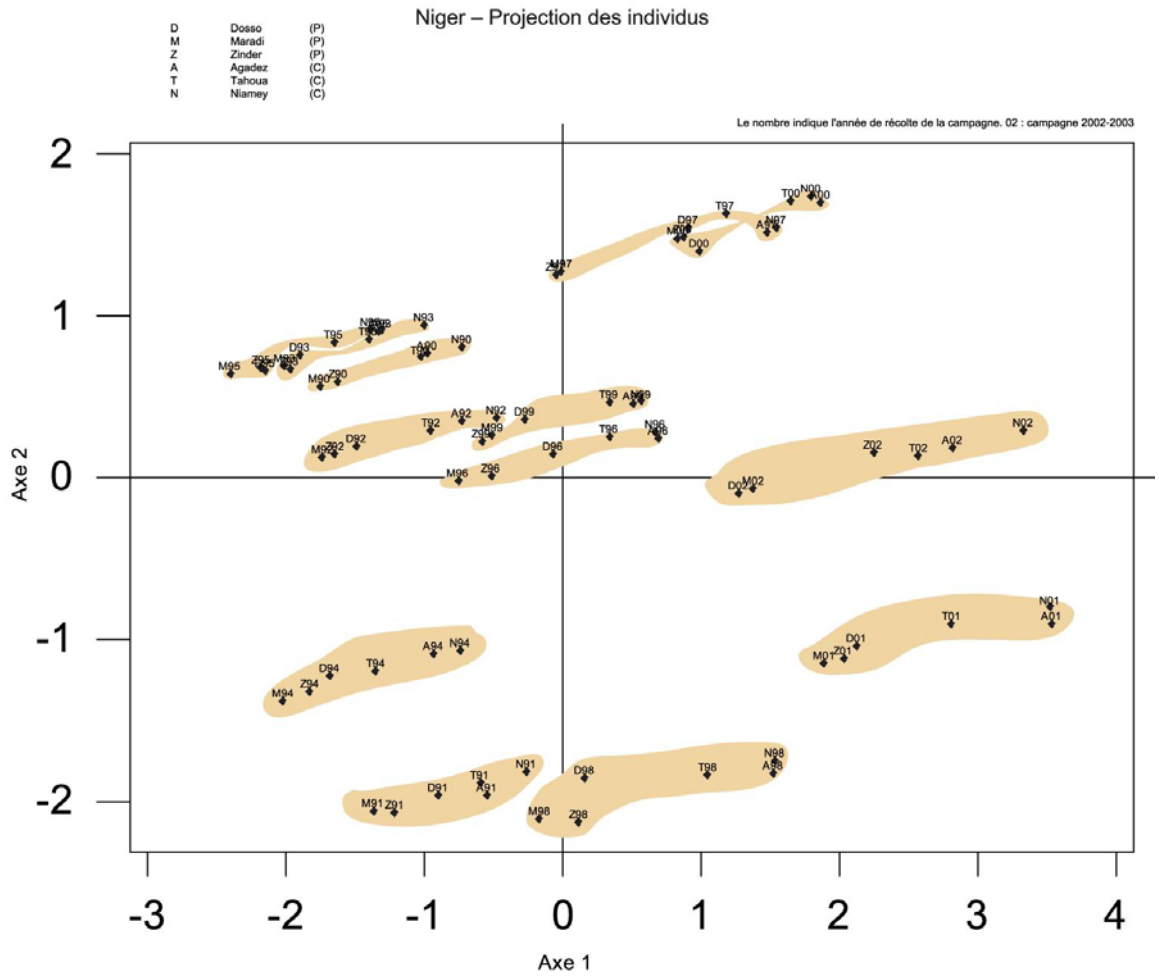
77 cases used 1 cases contain missing values

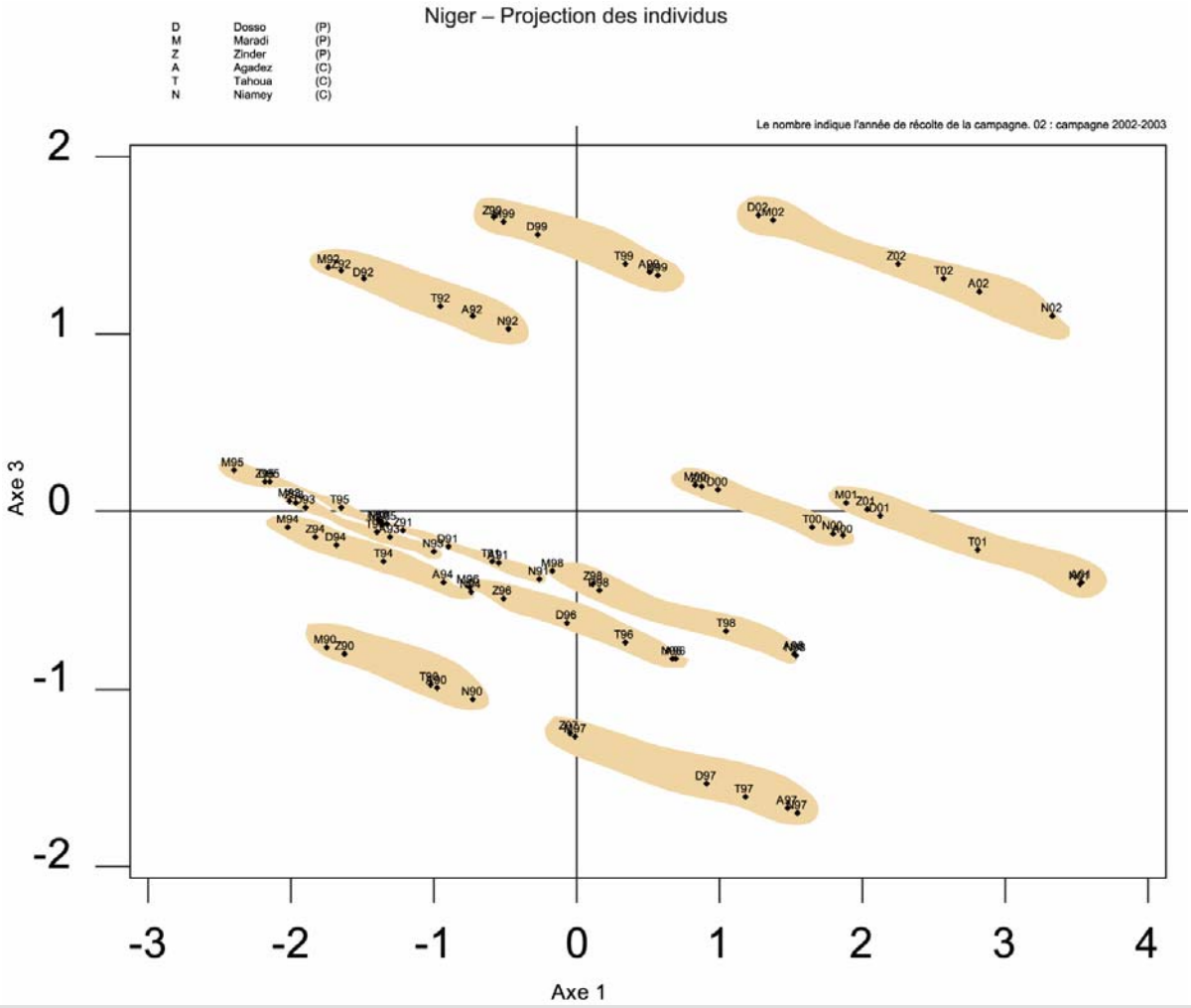
Eigenvalue	2,3798	1,3148	0,7755	0,4342	0,0956
Proportion	0,476	0,263	0,155	0,087	0,019
Cumulative	0,476	0,739	0,894	0,981	1,000

Variable	PC1	PC2	PC3
px09	0,587	0,005	-0,151
px15	0,579	0,305	-0,183
pn	0,170	-0,682	0,601
pn-1	-0,031	0,659	0,733
pnNGA	-0,539	0,080	-0,213






Niger – Projection des individus
D Dosso (P)
M Maradi (P)
Z Zinder (P)
A Agadez (C)
T Tahoua (C)
N Niamey (C)
Le nombre indique l'année de récolte de la campagne. 02 : campagne 2002-2003
Axe 2
Axe 1
2
1
0
-1
-2
-3
-2
-1
0
1
2
3
4



Burkina Faso

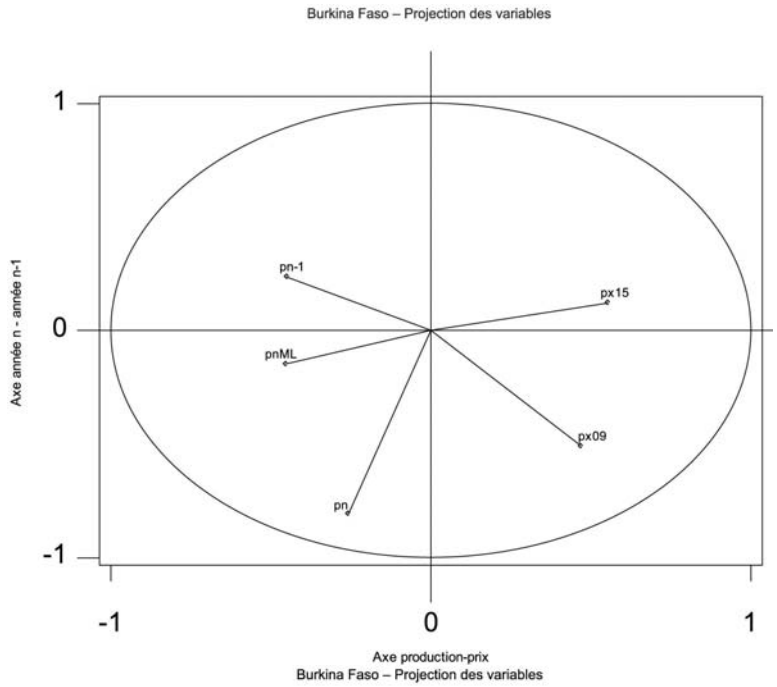
Principal Component Analysis: px09; px15; pnBF; pn-1; pnML

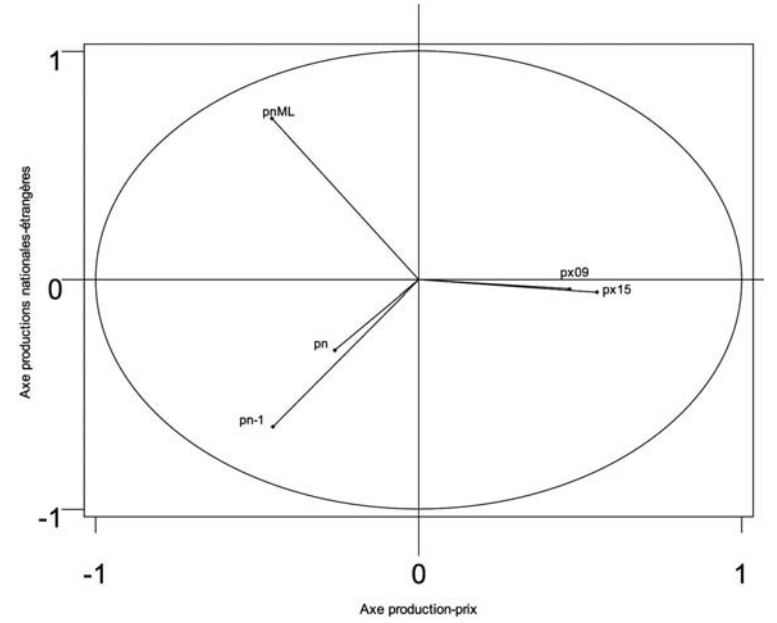
Eigenanalysis of the Correlation Matrix

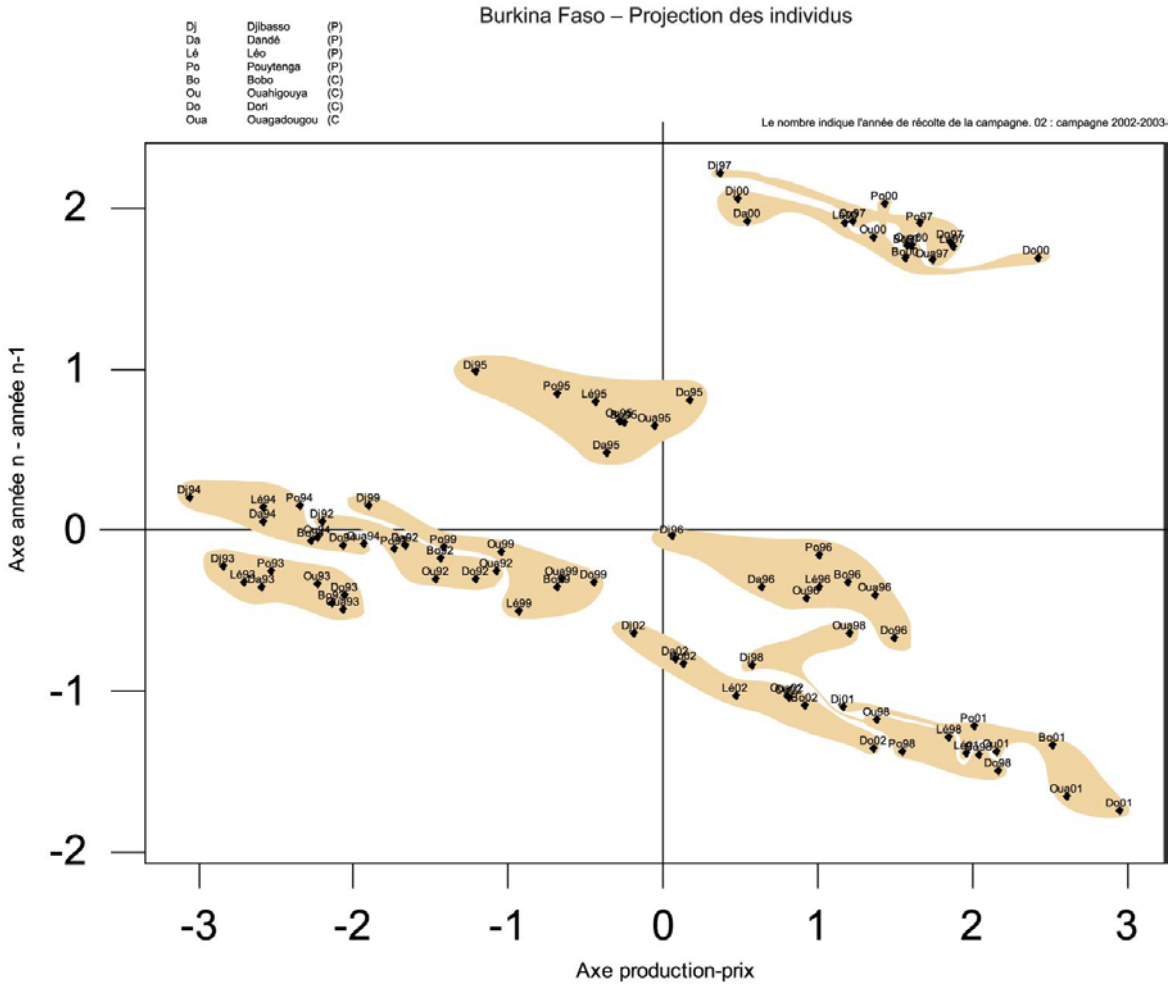
83 cases used 5 cases contain missing values

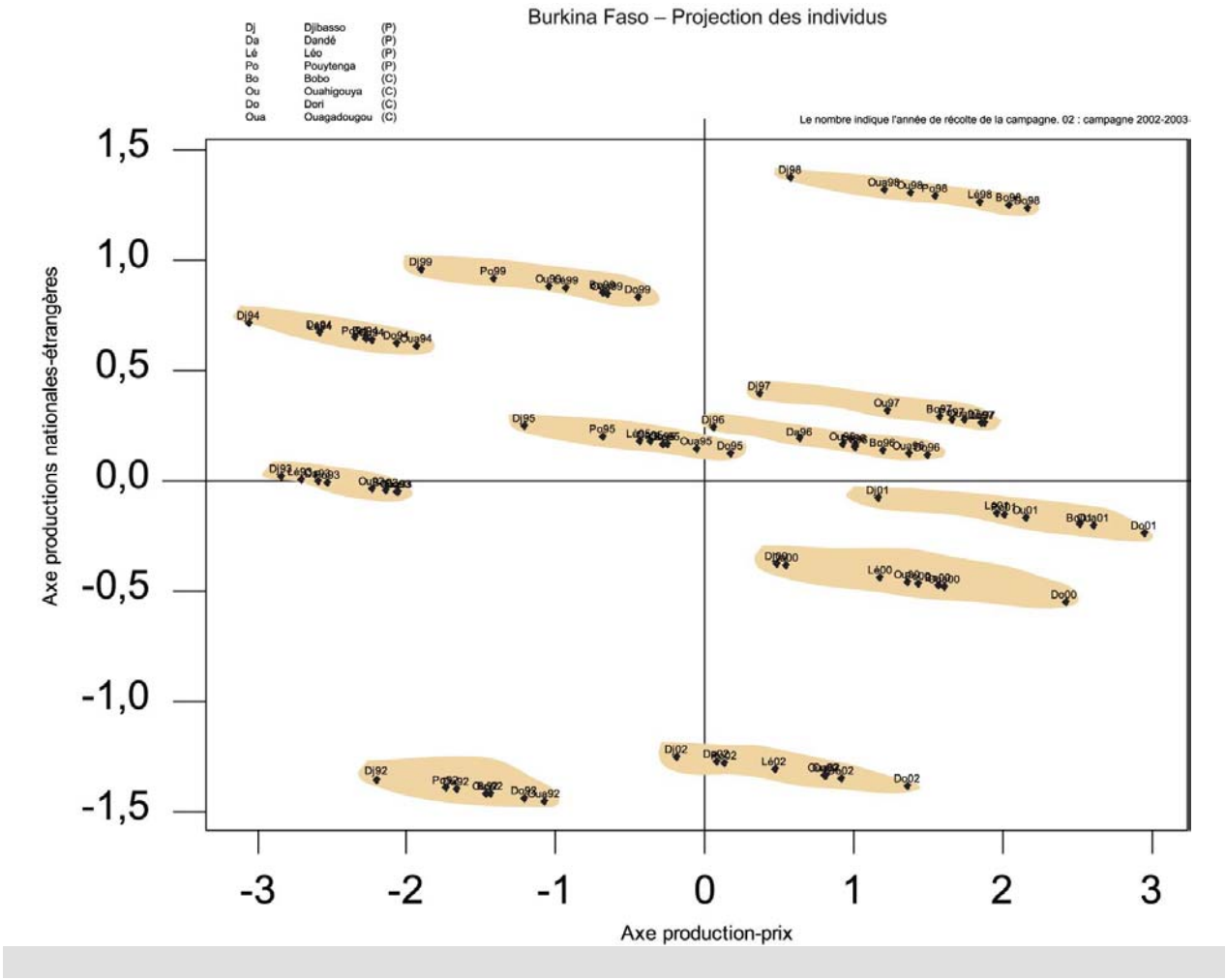
Eigenvalue	2,7112	1,1266	0,6245	0,3965	0,1412
Proportion	0,542	0,225	0,125	0,079	0,028
Cumulative	0,542	0,768	0,892	0,972	1,000

Variable	PC1	PC2	PC3
px09	0,466	-0,507	-0,038è
px15	0,553	0,128	-0,051
pnBF	-0,259	-0,805	-0,303
pn-1	-0,451	0,242	-0,637
pnML	-0,454	-0,146	0,706


Burkina Faso – Projection des variables
pn-1
px15
pnML
px09
pn
1
0
-1
-1
0
1
Axe année n - année n-1
Axe production-prix


Burkina Faso – Projection des variables
pnML
px09
px15
pn
pn-1
1
0
-1
-1
0
1
Axe productions nationales-étrangères
Axe production-prix


Burkina Faso – Projection des individus
Dj Djibasso (P)
Da Dandé (P)
Lé Léo (P)
Po Pouytenga (P)
Bo Bobo (C)
Ou Ouahigouya (C)
Do Dori (C)
Oua Ouagadougou (C
Le nombre indique l'année de récolte de la campagne. 02 : campagne 2002-2003-
Axe année n - année n-1
Axe production-prix
2
1
0
-1
-2
-3
-2
-1
0
1
2
3

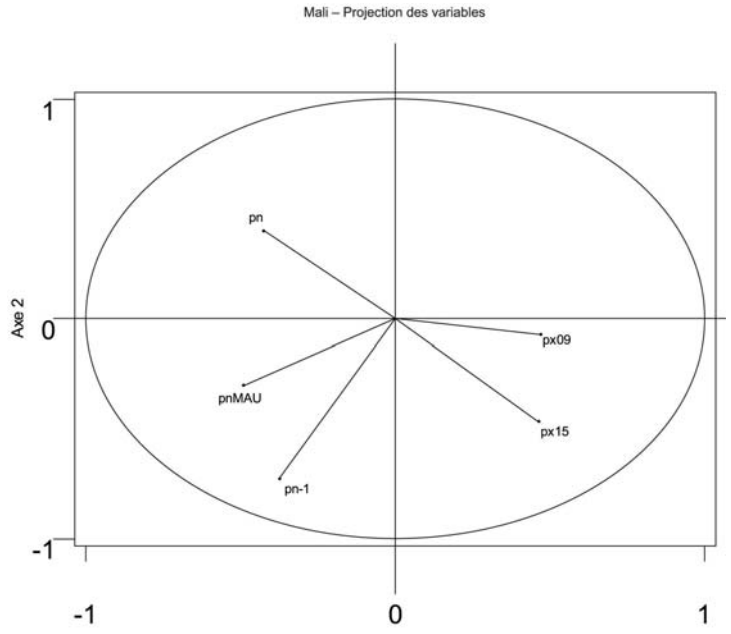

Burkina Faso – Projection des individus
Dj Djibasso (P)
Da Dandé (P)
Lé Léo (P)
Po Pouytenga (P)
Bo Bobo (C)
Ou Ouahigouya (C)
Do Dori (C)
Oua Ouagadougou (C)
Le nombre indique l'année de récolte de la campagne. 02 : campagne 2002-2003
Axe productions nationales-étrangères
Axe production-prix
1,5
1,0
0,5
0,0
-0,5
-1,0
-1,5
-3
-2
-1
0
1
2
3

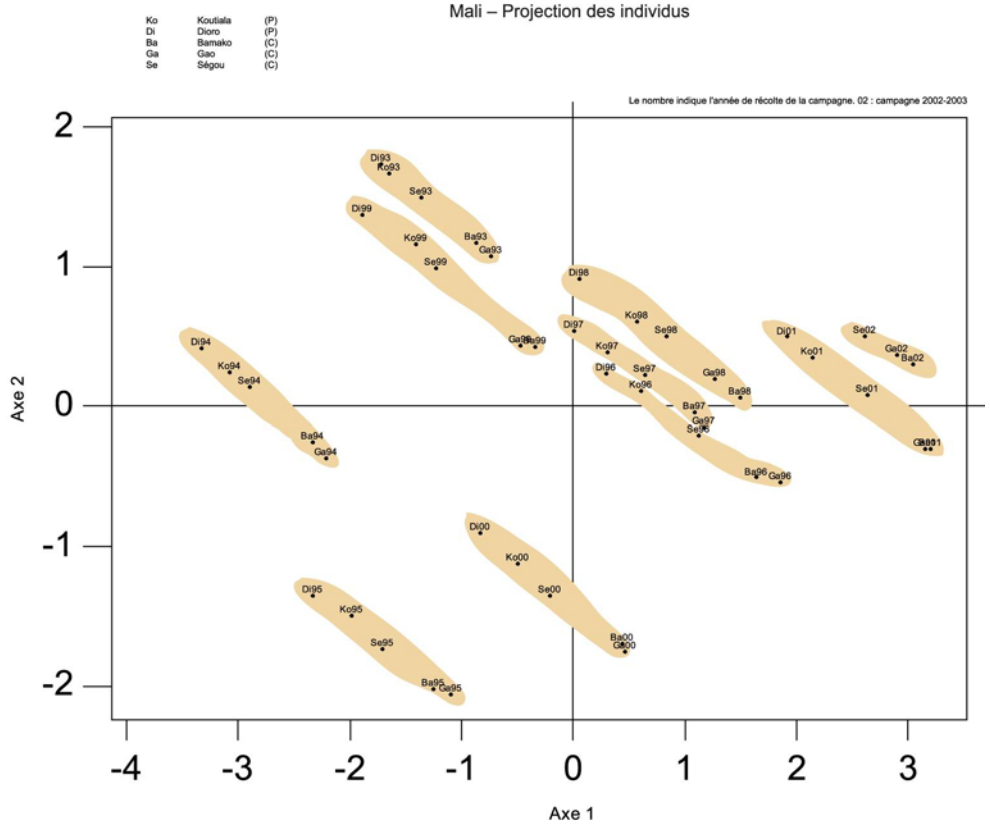
Principal Component Analysis: px09; px15; pn-1ML; pnML; pnMAU

Eigenanalysis of the Correlation Matrix

Eigenvalue	3,1398	0,9480	0,6553	0,2024	0,0544
Proportion	0,628	0,190	0,131	0,040	0,011
Cumulative	0,628	0,818	0,949	0,989	1,000

Variable	PC1	PC2	PC3
px09	0,470	-0,069	0,618
px15	0,466	-0,463	0,295
pn-1ML	-0,373	-0,727	-0,049
pnML	-0,426	0,401	0,630
pnMAU	-0,492	-0,301	0,361


Mali – Projection des variables
pn
px09
pnMAU
px15
pn-1
Axe 2
Axe 1
1
0
-1


Mali – Projection des individus
Ko Koutiala (P)
Di Dioro (P)
Ba Bamako (C)
Ga Gao (C)
Se Ségou (C)
Le nombre indique l'année de récolte de la campagne. 02 : campagne 2002-2003
Axe 2
Axe 1