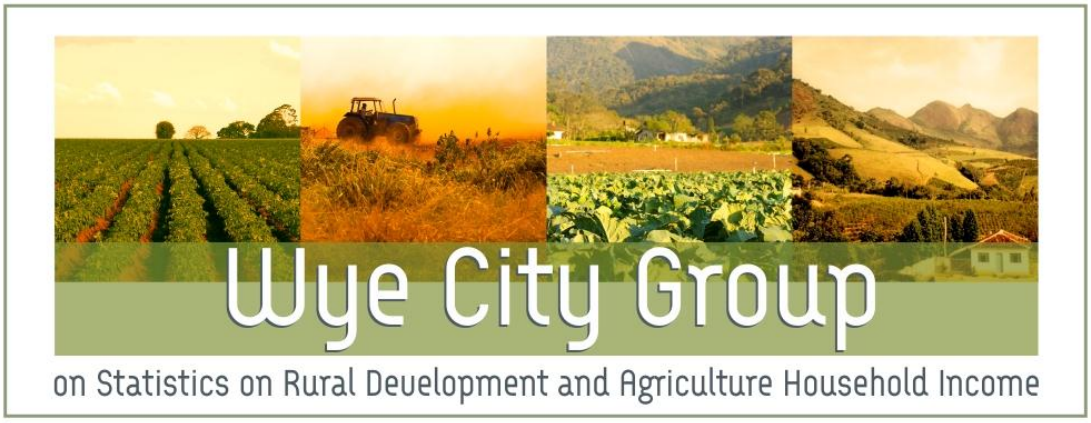

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Collection data measuring the interactions between climate change and agriculture in the agricultural statistics system of Burkina Faso

(Draft[1])

By

BAKO Dramane
Engineer Statistician Economist
Technical assistant of the general census of agriculture of Burkina Faso
Directorate of Forecasting and Agriculture and Food Statistics
Department of Agriculture (Burkina Faso)

And

YAMEOGO Sibiri
Statistician Economist
Directorate of Forecasting and Agricultural and Food Statistics
Department of Agriculture (Burkina Faso)

Abstract

The permanent system of agricultural statistics of Burkina Faso collects annually data on the interactions between climate change and agriculture. This information helps to identify the adaptation strategies of farmers to climate change and to measure quantitatively the impact of climate fluctuations on agricultural production. This paper presents the collecting process of this information and its use for estimating aggregates concerning the effects of climate change on agricultural production and household income well as the level of adaptation of the

[1] literature review and analysis are being improved

producers. We present the limits linked to the collection of this information and we make proposals for better information and better quality.

The data come from the permanent agricultural surveys of the period 2005-2010 and the general census of agriculture of 2008. The technique of matching and simulation with the social accounting matrix are used to assess the impact of climatic factors on production and income of farm households.

1. Introduction

Responsible for less than 4% of greenhouse gas emissions in the world, Africa is still the most affected continent by the phenomenon of climate change according to the analysis of IFPRI (IFPRI, 2007). This vulnerability is mainly due to the dependence of most of the continent's economies on agriculture and natural resources that are particularly sensitive to climate fluctuations.

Burkina Faso has suffered the last few years the disastrous effects of climatic phenomena that have particularly affected the agricultural sector. In 2004 and 2007, severe droughts have caused a significant decrease in agricultural production (-16% in 2007) emphasizing the food insecurity of rural populations and leading to a slowdown in growth of value added in agriculture (DGPSA, 2008). Also in 2009, floods have caused thousands of victims in the rural sector and the capital Ouagadougou.

Climate change is thus a real threat to the agricultural sector which plays an important role in the economy of Burkina Faso. It employs more than 80% of the workforce and contributes on average 32% to the GDP (DGPSA, 2008). Climatic events are a real constraint to the development of the country that needs a sustained growth of agricultural production for not only food security but also for the fight against poverty and growth in agricultural incomes which are the main source of currencies.

The phenomenon of climate change requires that measures of relevant policies be taken to reduce vulnerability of farm households to changes in climate and facilitate their adaptation. However, no effective policy is possible without the availability of reliable and timely data on the rural sector and particularly the interactions between climate change and farming. In Burkina Faso, the system of agricultural statistics made efforts to collect data to analyze the level of adaptation of the producers and their vulnerability to climate change.

2. Agriculture and Climate Change

According to the International Fund for Agricultural Development (IFAD), agriculture, the main source of livelihood for most rural poor, is the human activity most directly affected by climate change (IFAD, 2008). Studies and projections of the IPCC and IFPRI show that climate change will have generally negative impacts on agriculture and threaten food security worldwide (IPCC and al. 2007; IFPRI, 2009). The populations of the developing world, already vulnerable and food insecure, are likely to be most seriously affected (IFPRI, 2009).

Indeed, agriculture is extremely sensitive to climate change. Higher temperatures diminish useful crop yields while leading to a proliferation of weeds and pests. Changing precipitation patterns increase the probability of crop failure in the short term and a decrease in long-term production (IFPRI, 2009).

The effects of climate change on agriculture are already being felt in developing countries, where crop failure and livestock losses resulting from major financial losses and rising food prices, and still more often compromise food security, especially in some parts of sub-Saharan Africa. In some countries, yields of rain fed crops could fall 50% by 2020 (IFPRI, 2009). According to several scenarios, many climate models indicate a decrease in cereal production potential by 2080 in several African countries including Burkina (SP / CONEDD, 2006).

In most countries of the tropics, many climate models predict a decrease in rainfall. For example, this would decrease from 20% to 40% by 2050 according to the CCCM and UK89 models for Senegal and Guinea. In the middle of the blackboard, stand some countries like Burkina Faso, which should be given some increase in precipitation (from 5% to 10%) although a decrease is also possible; however, the uncertainty is large and did not suggest whether the country will benefit or suffer from the changes to come (ENPC, 2004, UNFCCC, 2001). The Projected rainfalls of the Panel on Climate Change in Burkina, however, give mixed results and variable depending on the season. They indeed show a relatively small overall decline in rainfall for 2025 (-3.4%) and 2050 (-7.3%) with high inter-annual and seasonal variability. The months of July, August and September will decreases from 20 to 30% of current rainfall, while November, December, January and February will see increases of 40-119% (SP / CONEDD, 2006).

With regard to changes in temperature, a consensus seems to emerge from the literature: Burkina will face a global increase of temperature by 2050. According to the Panel on Climate Change this increase will be 0.8°C in 2025 and 1.7°C in 2050 (SP/CONEDD, 2006).

The expected increase in rainfall and average temperature should favor higher yields of grain crops, but some may cause an increase in droughts and floods affecting agricultural production (SP / CONEDD, 2006, ENPC, 2004).

3. Adaptation strategies of producers to climate change

3.1. Characteristics of the homes of agricultural households

The housing characteristics are significant indicators of the vulnerability of farm households to flooding and high winds that are part of the most significant climate change in Burkina Faso. Information on the nature of housing is needed to understand the adaptation efforts of the producers during several periods.

The agricultural survey in Burkina collects information about the nature of the roof and the nature of the wall of households. This information is taken from all members of the household sample. The various terms of these variables are:

- Nature of the roof: 1=sheet metal, 2=mud, 3=straw, 4=other
- Nature of the wall: 1 = blocks (bricks), 2 = improved mud, 3 = mud 4 = straw / plant, 5 = other

Some definitions and instructions:

- **cinderblock wall**: wall crafted with cement bricks, stone cut in a hurry banco;
- **improved mud wall**: wall crafted using mud bricks, but covered with a layer of cement;
- **mud wall**: when mud is made up from the mud or mud bricks without cement plaster.
- a single wall whose interior is covered with cement will be considered in banco improved

The analysis of agricultural campaign 2009-2010 shows that in Burkina Faso, nearly 68% of the houses of farm households still have a roof mud or straw. In some areas, this proportion is over 80%. This reflects a high vulnerability to climatic events such as floods or high winds.

Over 83% of the houses of farm households have a wall made out of mud and straw or other plant materials although these are somewhat resistant to climate (see attached table).

3.2. The techniques of protection or conservation of land

Producers have a variety of techniques to protect their land from drought and floods to recover the degraded land. The agricultural survey collects information about these techniques on all plots of sample households. The terms are:

0 if the plot is not protected by any work;

1 if the parcel is protected by stone barriers;

2 if the parcel is protected by dikes filter;

3 if the method of the pipe is made on the parcel;

4 if the method is practiced zaï on the plot;

5 if the parcel is protected by the practice of ridges of earth;

6 If the parcel is protected by grass strips;

7 if the parcel is protected by windbreaks (hedgerows dead / or sharp);

8 If the parcel has other forms of protection.

If there are several techniques on the same field, the investigator must retain the one that the producer considers most effective.

The analysis shows that in 2010, 87.2% of agricultural plots had no anti-erosion device to adapt to drought, floods or be protected against other climatic phenomena.

3.3. The type of seed

The use of improved or selected seeds adapted to changes in climate is one of the methods of adaptation to climate change. On all household plots, the investigators asked the type of seed used.

Data analysis shows that less than 5% of a seed culture and only 1.1% of seed culture 2 are selected. Despite government efforts, the use of seeds adapted to climatic fluctuations is still low.

4. Influence of climate change on agricultural activity

4.1. Date of sowing

One of the impacts of climate change on agriculture is the disruption of the agricultural calendar. The agricultural survey collects data on planting dates in order to identify shifts in the rainy season.

The agricultural survey does not have enough periods to make a meaningful analysis of planting dates to highlight the possible disturbances of the agricultural calendar due to the climate change. Indeed, information on planting dates were fed into the agricultural statistics

only since 2004. However an analysis of available data shows significant shifts in planting dates during certain growing seasons due to climate fluctuations. There is a shift in the agricultural calendar for the years 2004 and 2007 because of drought and in 2009 especially because of flooding.

4.2. Agricultural practices that can promote the phenomenon of climate change

Some agricultural practices may result in the production of greenhouse gas (GHG) emissions. The agricultural survey in Burkina collects data on the quantities of chemical fertilizers used by farmers and their motorized equipment.

4.3. Assessing the impact of climate fluctuations on agricultural production and household income

4.3.1. Data collection on the factors of crop loss

Variables about the losses of production were included in the device of the permanent agricultural surveys of Burkina Faso from the 97-98 agricultural campaign. This allowed the estimation of such production losses and economic losses due to some factors. The figures are aggregated by region and then the national total is calculated.

The observation unit is like the plot followed by the fixed frame of the agricultural survey, the sampling component of crop loss is the same as that used for estimating yields, agricultural land area and production.

For each parcel of the household, the interviewer at the time of weighing of the squares of yield, raises the question about the phytopathological factors observed during the campaign. The head of the field shall indicate the factor that caused the most damage to crops. To facilitate data collection for non-specialists, loss factors identified were grouped into identifiable classes. The factors considered are:

00 if no loss has occurred;

01 if the square is affected by a flood;

02 if the square is affected by a bushfire;

03 if the square is affected by damage from animals (sheep, cattle ...);

04 if the square is affected by parasites (plant diseases);

05 if the square is affected by other pests (locusts, jacks and other insects);

06 if the square is affected by drought;

07 if the plot (and therefore the square) is not maintained;

08 if post-harvest losses were recorded;

09 if the plants were used for forage before harvest;

10 Other loss factors not mentioned above (specify).

4.3.2. Methodology

The study uses the technique of matching for the estimation of agricultural production losses related to two important climatic factors: drought and floods. Then the Social Accounting Matrix is used to assess the impact of these losses on household income.

4.3.3. The technique of matching

The matching method is used to highlight the level of lost production and performance related specifically to a given factor while isolating the influence of other factors. It allows the selection of observable characteristics X under the assumption of conditional independence (Rosenbaum and Rubin (1983)). It is therefore estimated for each plot, the individual probabilities of being affected by climatic factors conditional on observable characteristics X. The estimate of this function allows us to understand the process by which some plots have a higher probability of being affected. We have:

$$P(affected = 1 / X) = \frac{e^{X\beta}}{1 + e^{X\beta}}$$

For this, we realized a group of plots affected to a matched group of unaffected patches through characteristics for which performance is independent of whether or not to be affected by the factor selected. This technique allows to better evaluate the level of agricultural crop losses due to the factor.

4.3.4. The Social Accounting Matrix

This is a summary table of economic data for tracking a given year, all the flows of production, income, demand and exchange between different sectors of an economy

sufficiently disaggregated. As a representation of the whole economic system, the SAM serves to highlight the interrelationships and the circular flow of income between goods, production factors, and institutions. It is an effective tool for the analysis of socio-economic impacts of agricultural policies and rural development (FAO, 2006).

4.3.5. Results

Impact of floods

The floods have affected an average of 153 363 ha over the period 2005-2010. The 2007-2008 campaign was the most affected with over 242 000 ha of area affected. The loss of production the most important of the period as a result of flooding concerns rather the 2008-2009 campaign with a loss of more than 112 500 t. An analysis by crop shows that the crops most affected in terms of area in 2007-2008 had lower yield than those most affected in 2008-2009.

Table1: impact of floods on agricultural production and area

		Agricultural campaigns				
		2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
Impact of floods	area affected (ha)	36 895	77 292	242 692	234 544	175 395
	Production losses (ton)	9 319	35 108	112 230	112 694	67 159

Impact of drought

More than 1,437,000 ha of farmland have been affected by drought in 2007. It has created a drop of almost 12% of production compared to 2006. An average of over 275 000 t of production were lost on 5 years with a loss of more than 565 216 t in 2007.

Table2: impact of drought on agricultural production and area

		Agricultural campaigns				
		2005-2006	2006-2007	2007-2008	2008-2009	2009-2010
Impact of drought	Area affected (ha)	390 962	449 362	1 437 186	576 559	908 651
	Production losses (ton)	108 403	166 935	565 217	231 300	305 119

Rate of affected areas of crops by climatic factors

The rate of affected areas of a crop is the ratio of the areas affected by climatic factors on the total area sown of the crop.

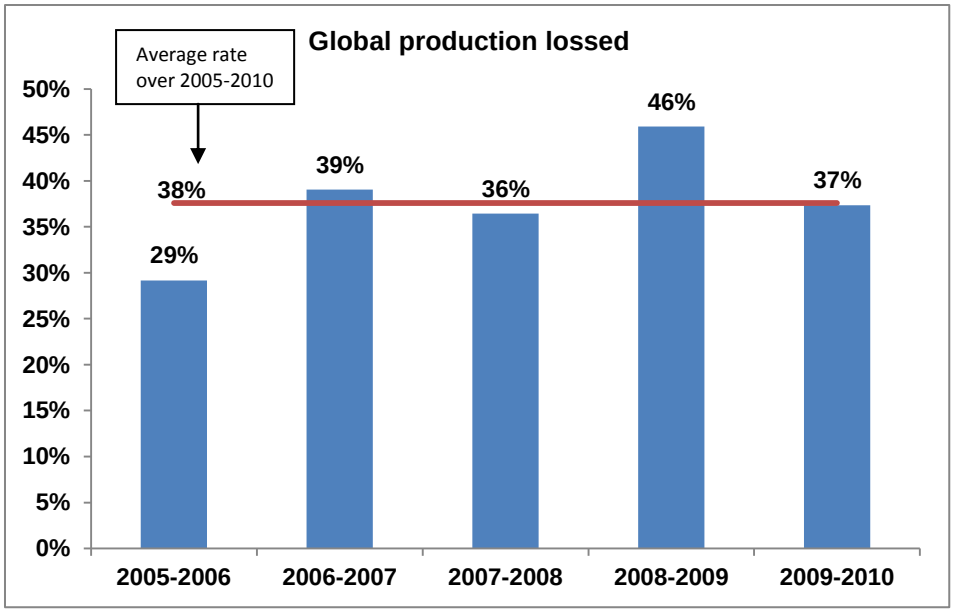
The analysis of the distribution of average rates of affected areas over the period 2005-2010 shows that crops with the areas most affected are mainly groundnuts, sesame, millet, soybeans, white sorghum and cowpea which an average rate of affected areas more than the loss threshold of 20%.

Rate of production loss of crop

The rate of production loss of crop is the ratio of production lost on potential output. Rice, potatoes, fonio, groundnuts, sesame, soybean and corn crops have emerged as the most affected in terms of production with rates of production loss more than 48%.

Rate of overall production loss

Over the last five (05) years, the average overall production loss due to climatic factors is estimated at 38%. The 2008-2009 campaign is one that has suffered the loss of production is higher. It has contributed to enhance Burkina global food crisis of 2008.



Impact on household income

The impact of agricultural losses due to climatic factors on household incomes has been simulated with the social accounting matrix.

Over the last five (05) years, we find that rural households were most affected. They suffered an average loss of more than 12.5% of their income which is more than twice the rate of loss of income of urban households (6.04%). This is related to the fact that rural households derive most of their income from agricultural activities and are therefore more vulnerable to climatic shocks on agriculture. Among rural households, those who are poor are more vulnerable and have a rate of loss of income more than 4 points higher than the one of non-poor rural households.

Table3: impact of climatic factors on household income

	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	Average of five years
Poor rural households	-11,27%	-15,09%	-14,08%	-17,74%	-14,43%	-14,52%
Non-poor rural households	-8,14%	-10,89%	-10,16%	-12,80%	-10,41%	-10,48%
Overall rural households	-9,70%	-12,99%	-12,12%	-15,27%	-12,42%	-12,50%
Poor urban households	-5,49%	-7,35%	-6,86%	-8,64%	-7,03%	-7,07%
Non-poor urban households	-3,89%	-5,21%	-4,86%	-6,12%	-4,98%	-5,01%
Overall urban households	-4,69%	-6,28%	-5,86%	-7,38%	-6,00%	-6,04%
Overall households	-7,70%	-10,31%	-9,62%	-12,11%	-9,85%	-9,92%

Source: our simulations

5. Conclusion

Agricultural activities are greatly impacts of climate change that causes a significant loss of production and agricultural land. In addition to food insecurity, these effects promote a decrease in producers' incomes.

This study analyses the vulnerability of rural households to climate change and estimated the total area affected and the amount of agricultural production lost as a result of two main climate factors: flooding and drought. The impact of these losses on the income of households has been simulated using a Social Accounting Matrix.

The results show that relative to potential output, the average rate of loss of production over the past five years is about 37.57% and poor rural households have lost more than 14.5% of their income because of weather. Rural households are more vulnerable than those with lower urban income twice.

Policy measures to promote adaptation to climate fluctuations producers should be strengthened in a context of food security and fight against poverty.

6. References

DGPSA, 2008. Evolution of the agricultural and living conditions of households in Burkina Faso, MAHRH, Ouagadougou

ENPC, 2004. The impact of climate change on agriculture in Africa. Climate Change Workshop, Paris

IFAD, 2008. Climate change: a challenge for development,

IFPRI, 2009. Climate Change: Impact on agriculture and adaptation costs. Food Policy Report, Washington, DC

IPCC et al. 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge, UK: Cambridge University Press.

Rosenbaum, Paul and Donald Rubin, 1983, "The Central Role of the Propensity Score in Observational Studies for Causal Effects," Biometrika, 70, 41-55.

SP / CONEDD, 2006. Assessment of vulnerability and adaptive capacity to climate change in Burkina Faso. Ministry of Environment and the living environment, Ouagadougou UNFCCC, 2001. United Nations Framework Convention on Climate Change, National Communication in Burkina Faso, Ouagadougou

7. ANNEX

Household's homes

Nature of roof

Regions	Nature of roof							
	Sheet metal		Mud		Straw		Other	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
Boucle du Mouhoun	515 002	32,2%	1 007 424	62,9%	69 723	4,4%	9 380	0,6%
Cascades	116 451	32,3%	12 764	3,5%	231 475	64,2%	0	0,0%
Centre	231 251	73,3%	4 595	1,5%	79 589	25,2%	0	0,0%
Centre-Est	415 721	43,5%	18 524	1,9%	521 658	54,6%	0	0,0%
Centre-Nord	231 793	20,1%	215 911	18,7%	703 433	61,1%	640	0,1%
Centre-Ouest	498 320	44,3%	464 521	41,3%	159 876	14,2%	937	0,1%
Centre-Sud	248 527	42,7%	73 976	12,7%	259 567	44,6%	0	0,0%
Est	250 356	19,9%	21 576	1,7%	987 319	78,3%	1 315	0,1%
Hauts-Bassins	569 043	47,2%	395 397	32,8%	240 184	19,9%	0	0,0%
Nord	333 586	27,2%	715 678	58,3%	178 052	14,5%	0	0,0%
Plateau Central	264 584	40,1%	37 857	5,7%	356 757	54,1%	0	0,0%
Sahel	32 107	3,4%	554 871	59,1%	323 618	34,5%	27 629	2,9%
Sud-Ouest	100 032	18,4%	372 569	68,4%	72 070	13,2%	45	0,0%
Total	3 806 772	31,9%	3 895 663	32,7%	4 183 322	35,1%	39 948	0,3%

Nature of wall

Régions	Nature du mur									
	blocks (bricks)		improved mud		mud		straw / plant		other	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
Boucle du Mouhoun	41 853	2,6%	192 912	12,0%	1 352 289	84,5%	10 932	0,7%	3 290	0,2%
Cascades	14 724	4,1%	34 131	9,5%	309 552	85,8%	1 000	0,3%	1 284	0,4%
Centre	12 077	3,8%	62 088	19,7%	218 159	69,1%	10 703	3,4%	12 799	4,1%
Centre-Est	90 369	9,5%	170 882	17,9%	685 677	71,9%	7 031	0,7%	177	0,0%
Centre-Nord	0	0,0%	85 027	7,4%	1 032 873	89,7%	32 992	2,9%	886	0,1%
Centre-Ouest	26 629	2,4%	161 822	14,4%	925 952	82,4%	9 559	0,9%	0	0,0%
Centre-Sud	46 925	8,1%	178 650	30,8%	277 555	47,8%	27 647	4,8%	50 179	8,6%
Est	18 375	1,5%	121 045	9,6%	1 058 633	84,2%	59 005	4,7%	877	0,1%
Hauts-Bassins	53 136	4,4%	140 500	11,7%	1 005 605	83,5%	4 572	0,4%	801	0,1%
Nord	19 064	1,6%	136 607	11,1%	1 031 050	84,0%	40 378	3,3%	0	0,0%
Plateau Central	18 488	2,8%	146 500	22,3%	483 565	73,4%	5 249	0,8%	4 602	0,7%
Sahel	1 568	0,2%	66 964	7,2%	691 463	74,1%	173 631	18,6%	0	0,0%
Sud-ouest	31 164	5,7%	45 120	8,3%	466 281	85,8%	1 100	0,2%	0	0,0%
Total	374 371	3,1%	1 542 248	12,9%	9 538 654	80,1%	383 799	3,2%	74 895	0,6%

Techniques of protection or conservation of lands

anti-erosion device	Count	Column N %
Nothing	9 767 867	87,2%
Stone barriers	911 138	8,1%
Dikes filter	19 677	0,2%
« Half moon »	9 207	0,1%
« Zaï »	135 669	1,2%
Bidges of clay	119 926	1,1%
Grass strips	92 659	0,8%
Hedgerows dead / or sharp	144 199	1,3%
Other	5 768	0,1%
Total	11 206 110	100,0%

Use of improved seed

Region	Type of seed crop 1				Type of seed crop 2			
	Local		Improved		Local		Improved	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
Boucle du Mouhoun	3 745	89,3%	451	10,7%	1 100	98,3%	19	1,7%
Cascades	1 468	91,8%	132	8,3%	329	100,0%	0	0,0%
Centre	785	97,5%	20	2,5%	290	99,7%	1	0,3%
Centre-Est	2 641	95,9%	106	3,9%	1 217	99,1%	7	0,6%
Centre-Nord	2 396	99,7%	7	0,3%	1 152	98,9%	13	1,1%
Centre-Ouest	3 632	94,6%	208	5,4%	1 523	98,8%	18	1,2%
Centre-Sud	3 008	98,3%	51	1,7%	1 011	99,2%	8	0,8%
Est	2 905	98,1%	56	1,9%	989	99,9%	1	0,1%
Hauts-Bassins	2 196	87,1%	324	12,9%	455	98,9%	5	1,1%
Nord	2 835	99,5%	13	0,5%	1 387	99,4%	8	0,6%
Plateau Central	2 832	98,1%	48	1,7%	1 273	98,8%	10	0,8%
Sahel	810	98,4%	13	1,6%	285	88,2%	38	11,8%
Sud-ouest	2 849	92,8%	221	7,2%	1 541	99,2%	12	0,8%
Burkina	32 102	95,1%	1 650	4,9%	12 552	98,8%	140	1,1%

Date the maximum number of producers has started sowing

Region	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Boucle du Mouhoun	10 June	20 June	10 June	7 July	20 June	20 June
Cascades	10 June	5 June	15 June	10 July	10 June	16 June
Centre	10 July	20 June	20 July	20 July	15 June	10 July
Centre-Est	20 June	10 June	15 June	10 July	10 June	10 June
Centre-Nord	7 July	20 June	15 July	20 July	10 July	26 June
Centre-Ouest	15 June	10 June	5 June	20 July	10 June	15 June
Centre-Sud	6 June	10 June	6 June	15 July	10 June	10 June
Est	10 June	10 June	10 June	10 July	10 June	10 June
Hauts-Bassins	10 June	9 June	9 June	20 July	20 June	20 June
Nord	20 July	4 June	20 July	15 July	10 July	10 July
Plateau Central	15 July	14 July	14 July	20 July	10 July	10 July
Sahel	2 June	4 June	19 July	6 July	19 June	13 June
Sud-Ouest	10 June	9 June	9 June	15 June	14 June	10 June
Burkina	10 July	20 June	10 June	21 July	21 June	11 July