Project no. **015403**

FONIO

Upgrading quality and competitiveness of fonio for improved livelihoods in West Africa

Specific targeted research project (STREP)

INCO

First activity report

Period covered: **1 January to 31 December 2006** Date of preparation: **January 2007**

Start date of project: **1 January 2006** Duration: **3 years**

Project coordinator name: **Jean-François CRUZ (jean-francois.cruz@cirad.fr)**

Project coordinator organisation name:
CIRAD (International Cooperation Centre in Agronomic Research for Development) - France

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Executive summary

Context

Traditional cereals constitute the staple diet of many African populations and regions, especially in the most isolated rural areas, and play an essential role in providing food for the poorest populations. They are well suited to local conditions, being reasonably resistant to drought, and help to maintain the environment by providing a covering of vegetation on ground which is ecologically fragile, and considered of little value.
Among traditional cereals, fonio (*Digitaria exilis*), is considered as the most ancient indigenous West African cereal. Nowadays, fonio still grows in farmers' fields in a vast area extending from Senegal to Chad mainly on eroded lateritic soils. In West Africa, farmers cultivate mainly white fonio *(Digitaria exilis)*, which is also called fundi, findi, acha or "hungry rice". The term 'hungry rice' well describes the role of this little plant in local population life. Fonio supplies to several million people food early in the growing season, when main crops are still too immature to be harvested and when other food resources are scarce. Fonio consumption varies between years and seems to be dependent on the availability of other cereals. When other cereals are not available, for example due to a failing harvest, fonio consumption is high, and thus fonio consumption could be considered as one of the coping strategies for increasing household food security.
The relative stagnation of production is partly explained by a lack of research and development devoted to this product. In order to ovoid the decline of this commodity, it is important to solve the many problems after the harvest, in particular by perfecting post-harvested techniques and by improving the quality and the follow-up of sales and distribution.
Today, fonio is produced by small enterprises and sold not only on local urban markets, but also to Africans emigrated in Europe and in United States. Indeed several small private enterprises, notably in Mali and Burkina, have been set up to cater for the export markets. There is strong consumer demand for fonio due to its nutritional qualities, and because it helps to satisfy the demand for a more varied cereal diet.
That is the reason why a research/development project named *FONIO - Upgrading quality and competitiveness of fonio for improved livelihoods in West Africa*- was elaborated to achieve the following objectives. The FONIO project started formally at January 1, 2006 per three years duration.

Objectives

FONIO's objective is to upgrade quality and competitiveness of fonio in West Africa by improving production (adapted varieties, appropriated production and farming systems, …), technology (innovation in post-harvest mechanisation and processing,…) and marketing systems for local and export markets. In Africa, the increasing interest for fonio, as well from consumers than from small enterprises, demonstrates the possibility for the development of good quality products based on fonio. For European consumers, the desirable criteria are nutritional quality, originality, healthier properties and environmental friendliness. The production of exportable value added fonio products is conceivable and must be promoted.

To achieve the overall objective, FONIO project promote an interdisciplinary and innovative approach involving scientists from various backgrounds: food technology, nutrition, process engineering, mechanization, social sciences, and agronomy. It support research/development actions with a participatory approach involving producers, processors, women's groups and small enterprises that will benefit directly and quickly from the research results.

The main research activities (workpackages) of the project are the following:
WP1 - Diversification of fonio products for niche export markets and local markets
WP2 - Nutritional aspects of fonio and fonio products
WP3 – Demand for new products and its effects on income generation and distribution
WP4 - Small scale enterprises and innovation in product and process
WP5 - Opportunities for diversification and multipurpose uses of fonio in crop-livestock systems
WP6 - Improving knowledge on fonio based cropping systems and ways for improving productivity

Participants

Research scientists are from three European countries and four West African developing countries (Mali, Guinea, Burkina Faso and Senegal). They belong to Research centres, Universities, National or International Research Systems.
Three from European countries:
Participant 1: Cirad (International Cooperation Centre in Agronomic Research for Development) France,
Participant 2: Wageningen University (Division of Human Nutrition) The Netherlands,
Participant 3: CRA-W (Walloon Center of Agricultural Research) Belgium.
Four participants from West African countries:
Participant 4: IER (Institut d'Économie Rurale) Mali.
Participant 5: IRAG (Institut de Recherche Agronomique de Guinée) Guinée.
Participant 6: CIRDES (Centre International de R&D sur l'Élevage en zone Subhumide) Burkina Faso.
Participant 7: ENDA-GRAF (Groupes Recherches Actions Formations) Sénégal.

The co-ordinator of the project is Jean-François CRUZ, CIRAD, Research Unit 24 " Tropical Food Quality » Maison de la Technologie, 73 rue Jean-François Breton. 34398 Montpellier Cedex 5 - France
Email : jean-francois.cruz@cirad.fr

Work completed

The first three months of operations were primarily given over to funding aspects (opening of accounts by partners, transfer of funds, etc), defining administrative and financial procedures and preparing and holding the project kick-off meeting.

Kick-off meeting

The project kick-off meeting was held in Bamako, Mali, from 20 to 24 March 2006.
The meeting, which was organized jointly by CIRAD and IER, was attended by some forty people from the various partner organizations in Europe (France, the Netherlands and Belgium) and West Africa (Mali, Guinea, Burkina Faso, Senegal and Benin), and representatives of the private sector in Mali: AOPP (Association des Organisations Paysannes et Professionnelles), FENATRA (Fédération Nationale des Transformateurs) and SMEs (processors, women's groups, EIGs, etc).

The meeting was led by the project's overall coordinator (J.F. Cruz) and chaired by Dr Oumar Niangado, and set out to present the different partners in the project, finalize the annual programme of activities for 2006, and determine the strategies to be adopted to achieve the objectives set by the project. It was also very useful for creating links between the various researchers present and facilitating future collaboration. Lastly, the first workshops for WPs 5 and 6 were also held during the meeting.

This kick-off meeting in March 2006 thus marked the real start of the project, although the official date was 1 January 2006.

Activities completed

The second quarter of 2006 was given over to the actual launch of the FONIO project in the field. The first activities primarily concerned work packages 5 and 6, which needed to define their sectors of intervention (choice of sites for preliminary studies in each country, methodological approaches, etc) and to prepare for the agricultural season and trials at experimental stations. Over the same period, WPs 1 to 4 concentrated on drawing up identification and interview documents and carrying out surveys. These various documents were then finalized at the workshop for WPs 1 to 4 in Dakar in June 2006.

The main activities were thus conducted during the second half of the year. Given the constraint of the cropping calendar, WPs 5 and 6 naturally conducted the major part of their operations (on-station trials, diagnosis of cropping and production systems, etc) during the agricultural season, from sowing (June-July) to harvesting (September-October). The other WPs spent their time on the first field surveys (WPs 1, 2, 3 and 4) and the first tests of precooking and drying equipment (WP1).

WP1 is coordinated by Cirad (France) and concerns "Diversification of fonio products for niche export markets and local markets". During 2006, task 1.1 has started by the identification of quality criteria of fonio in Bamako when buying, processing or consuming it depending of the fonio types (hulled, whitened, precooked) or the stakeholders involved (wholesalers, retailers, processors, cookers, consumers). Quantitative surveys were conducted through individual or focus group interviews by using open and semi-structured questionnaires, then were completed by sensorial tests (rank tests and triangular tests) in order to have a better perception of consumer preferences of cooked fonio. Task 1.2 has started by an identification of existing cooking processes in Burkina Faso. The first experiments in fonio parboiling at laboratory level have started by a study of grain behaviour during soaking and steaming with the measurement of technological and cooking properties but also the colour and starch characteristics. During this first year of the project, task 1.3 has been focused on drying mechanization. After the achievement of engineering drawings, two types of driers (*cross-flow drier* and *greenhouse ventilated solar drier*) have been locally manufactured and tested with a processor. Experiments in rainy or dry seasons will be progressing next year in comparison with two other existing driers.

WP2, led by Wageningen University (The Netherlands) concerns "nutritional aspects of fonio and fonio products". The activities of the WP2 in 2006 were mainly focussed on preparatory work for substudy 1 (nutrient value of fonio and fonio products), substudy 2 (food consumption and role of fonio in dietary patterns) and substudy 3 (contribution of fonio to nutrient intake and nutrition status). In June 2006, the detailed proposals for the pilot studies were finalised. Literature research on nutrient values of fonio was finalised. Fieldwork concerning preparing the different sub-studies was carried from June-August 2006. Nutrient variation in different fonio varieties, effect of women's processing skills on nutrient content and effect of processing on nutrient content of fonio and fonio products were determined in a pilot study. Chemical analysis of nutrient content of fonio and fonio products took place in The Netherlands. Preparatory work for substudy 2 comprised development of a sampling frame, compilation and updating of the Mali food composition table, listing of foods available in Bamako including selling units and prices, characterising of meal pattern of households in Bamako including composition of main dishes consumed, listing of household utensils used in meal preparation and eating in households including volume and weight. Analysis took place in Wageningen and based on this detailed proposals for sub studies 1, 2 and 3 were developed.

WP3 led by Cirad concerns "demand for new products and its effects on income generation and distribution". To pinpoint that demand, based on prior studies of consumption, fonio product quality characteristics were determined through focus groups and individual surveys of consumers, fonio buyers, processors of traditional and new products, restaurant owners and traders (retailers and wholesalers). For each type of product and each player, the desired characteristics taken into account varied depending on the planned uses. A survey was conducted in Bamako of 174 purchases of hulled, whitened or whitened-washed fonio, and 65 precooked products. The analysis was intended to demonstrate the characteristics that currently determine retail prices. It revealed that the degree of hulling/processing accounts for almost every price variation. "Size", "colour" and "origin" characteristics have only a slight effect on prices, and only in the case of hulled and/or whitened fonio. As regards precooked fonio, the main source of price variations is the point of sale, while cleanness also apparently plays a role, albeit a less significant one. The "hedonic price" estimation method was used to calculate the implicit value that consumers place in the different characteristics. The production chain surveys (activity 3.3) were conducted in Mali, Guinea and Senegal. The results will be available in 2007.

WP4 is led by ENDA Graf (Senegal) and concerns "small firms and innovation in terms of products and processes". During 2006, a typology of fonio processing firms in Senegal was produced, identifying two types of SMEs: "domestic" SMEs are primarily characterized by their low production levels (less than 500 kg/year), the absence of dedicated infrastructures and a lack of mechanical processing equipment. "Mechanized" SMEs have at least one operational huller, cooking equipment, a clean building more or less suitable for production, an annual processing volume of at least a tonne and the capacity to pack their end products in polythene bags. A third type, more similar to small-scale enterprises, is made up of firms that do not process fonio but buy it from local firms and sell it on the export market under their own label.

WP5, directed by Cirdes (Burkina Faso) is entitled "Opportunities of diversification and multiple uses of fonio in production systems", has several objectives. The year 2006 was given over to the first objective, an analysis of the range of fonio-based production systems and importance of fonio in the production system. This meant a survey of 300 farmers in Guinea, Mali and Burkina Faso, evenly distributed throughout the main fonio production basins (two basins/country). In Burkina Faso, fonio production is split between two basins, one in a semi-arid zone (Kossi Province) and the other in a subhumid zone (Kenedougou and Houet Provinces). The typology revealed five types of production unit, according to the extent of fonio growing, the fonio volumes marketed and the proportion of fonio grown by women. Fonio accounts for 17% of cropping plans on average. It is a stopgap crop, primarily eaten from September to November. The volumes marketed are low. In the four villages surveyed, 13 local varieties were identified, split between early, intermediate and late varieties. Producers in the North prefer early varieties. Fonio is primarily sown on sandy plain soils, broadcast in freshly ploughed fields, and covered over using branches. It requires little upkeep (one weeding round) and no inputs, and has few enemies (striga). It is cut with a sickle between September and October, and produces 500 to 600 kg of grain/ha after threshing. Cutting, threshing and hulling are done by hand and are highly labour-intensive. Fonio is stored in grain lofts and keeps for several years without any particular treatments. The volumes sold are low and prices vary according to the type of product (paddy or hulled) and the time of year (after harvesting or at the end of the dry season).

WP6 is led by CRAW (Belgium) and involves IRAG, IER, CIRAD and CIRDES. The aim of WP6 is to find out more about fonio-based cropping systems and look at ways of improving productivity, in line with the production chain's expectations.

Firstly, the diversity and the plasticity were explored, in term of cycle length and production potential, of the varieties in collection or collected in three main area of production, corresponding to three eco-regional zonation from Guinea to Burkina Faso. To do so, the production potential of a panel of varieties with level of precocity ranged from 90 to 150 days was compared in a multilocal design, within three experimental stations, after a depth work of recorded parameters standardisation. In parallel, a state of the art exploring the knowledge existing on fonio varieties and fonio farming systems was established.

Secondly, the fonio response to abiotic parameters has been analysed with a special attention for soil, nutrients and climate parameters. In 2006, preliminary experiments were set up (1) to identify the main aspects (nutrients of interest, photo-period sensitivity,…) to explore in depth in 2007 and 2008 and (2) to characterize the heterogeneity of the fields to be used in 2007 to set up nutrients response experiments. This was done in parallel to the establishment of a climatic data-base across all the area of interest.

Thirdly, in collaboration with the WP5, the WP6 researchers participated to the definition of the survey aiming to diagnose present fonio based cropping systems and of the future follow up aiming to quantify actual biophysical performances under farmers conditions. This will allow to quantify the gap between the actual and the potential productivity and to identify, with the farmers, in the last step of this project, the ways to fill this gap.

Dissemination of knowledge

Very few results were available by the end of this first operational phase. This is quite normal, since the first year was primarily given over to setting up the project in the field, collecting plant material for the first trials on experimental stations and conducting the first surveys of producers, processors and consumers.

The most important advance in terms of disseminating information was the launch of a website six months after the kick-off date. Its URL is http://inco-fonio.cirad.fr/.

Several web pages have also been produced on the European FONIO project:
"CIRAD" page
http://www.cirad.fr/en/actualite/communique.php?id=501
"European Union" pages
http://ec.europa.eu/research/headlines/news/article_06_09_22_en.html
http://cordis.europa.eu/fetch?CALLER=EN_NEWS&ACTION=D&SESSION=&RCN=26409

Section 1 – Project objectives and major achievements during the reporting period

General project objective and current relation of the project to the state-of-the-art

The overall objective of FONIO project is to upgrade quality and competitiveness of fonio in West Africa by improving production (adapted varieties, appropriated production and farming systems, …), technology (innovation in post-harvest mechanisation and processing,…) and marketing systems for local and export markets. In Africa, the increasing interest for fonio, as well from consumers than from small enterprises, demonstrates the possibility for the development of good quality products based on fonio. For European consumers, the desirable criteria are nutritional quality, originality, healthier properties and environmental friendliness. The production of exportable value added fonio products is conceivable and must be promoted.

After nine months of real activity of the project, it is necessary to remind the state of art that was established to justify the project proposal

Traditional cereals constitute the staple diet of many African populations and regions, especially in the most isolated rural areas, and play an essential role in providing food for the poorest populations. They are well suited to local conditions, being reasonably resistant to drought, and help to maintain the environment by providing a covering of vegetation on ground which is ecologically fragile, and considered of little value.

Among traditional cereals, fonio (*Digitaria exilis*), is considered as the most ancient indigenous West African cereal. Nowadays, fonio still grows in farmers' fields in a vast area extending from Senegal to Chad mainly on eroded lateritic soils. The total area under production is estimated at 350 000 hectares, and production reaches 250 000 tons per year with average yields of about 700 kg/ha. For many rural populations fonio is a staple food especially for communities in the mountainous areas of Fouta Djalon in Guinea. Farmers in Mali, Burkina Faso, Ivory Coast, Nigeria, Senegal,… also cultivate this small cereal. In West Africa, farmers cultivate mainly white fonio *(Digitaria exilis)*, which is also called fundi, findi, acha or "hungry rice". The term ‘hungry rice’ well describes the role of this little plant in local population life. Fonio supplies to several million people food early in the growing season, when main crops are still too immature to be harvested and when other food resources are scarce. Fonio consumption varies between years and seems to be dependent on the availability of other cereals. When other cereals are not available, for example due to a failing harvest, fonio consumption is high, and thus fonio consumption could be considered as one of the coping strategies for increasing household food security.

The relative stagnation of production is partly explained by a lack of research and development devoted to this product. In order to ovoid the decline of this commodity, it is important to solve the many problems after the harvest, in particular by perfecting post-harvested techniques and by improving the quality and the follow-up of sales and distribution.

Today, fonio is produced by small enterprises and sold not only on local urban markets, but also to Africans emigrated in Europe and in United States. Indeed several small private enterprises, notably in Mali and Burkina, have been set up to cater for the export markets. There is strong consumer demand for fonio due to its nutritional qualities, and because it helps to satisfy the demand for a more varied cereal diet.

To achieve the overall objective presented above, FONIO project promote an interdisciplinary and innovative approach involving scientists from various backgrounds: food technology, nutrition, process engineering, mechanization, social sciences, and agronomy. It support research/development actions with a participatory approach involving producers, processors, women’s groups and small enterprises that will benefit directly and quickly from the research results.

The workplan is divided into 6 workpackages gathering the following research activities:

WP1 - Diversification of fonio products for niche export markets and local markets
WP2 - Nutritional aspects of fonio and fonio products
WP3 – Demand for new products and its effects on income generation and distribution
WP4 - Small scale enterprises and innovation in product and process
WP5 - Opportunities for diversification and multipurpose uses of fonio in crop-livestock systems
WP6 - Improving knowledge on fonio based cropping systems and ways for improving productivity

presented graphically as below:

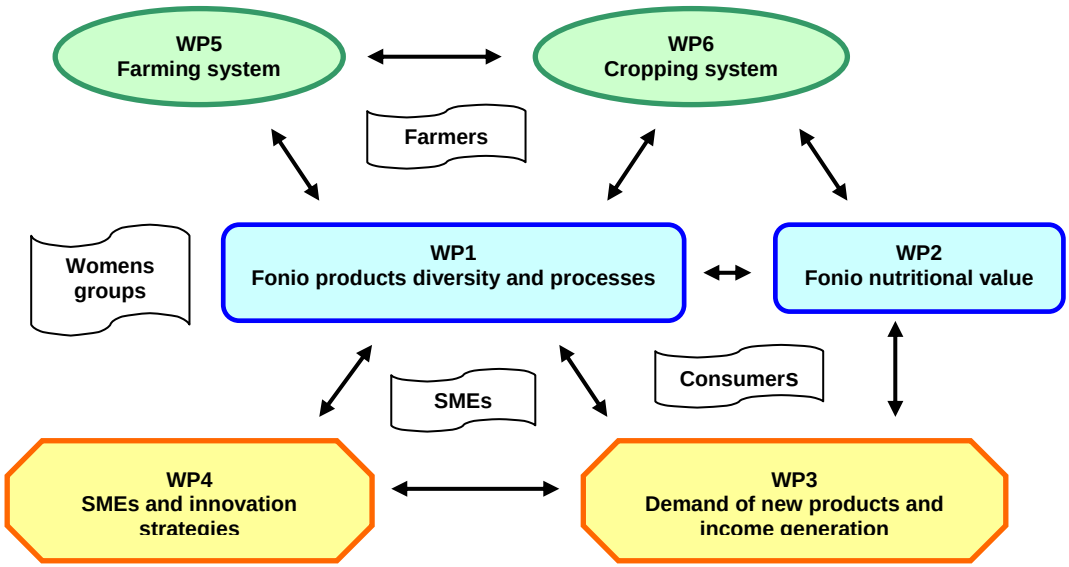


Fig. 1: Graphical presentation of FONIO work packages

Summary of the objectives, work performed, contractors involved and main achievements during the first reporting period.

WP1 is directed by Cirad (France) in close cooperation with IER (Mali). The main WP1 objective is to develop high quality fonio products with appropriate processes for local markets in West Africa and for exports.

During the first reporting period, the specific objectives of WP1 was
1 - to precise quality criteria of milled and cooked fonio
2 - to start studies for producing precooked and parboiled fonio products with constant and improved technological, organoleptic and nutritional qualities
3 - to develop equipments adapted for drying fonio grain and products

Major achievements during the reporting period concern:

- -The identification of quality criteria of milled and cooked fonio in Bamako by all the stakeholders that play a role all along the fonio chain and at different steps : when they buy, when they process and when they consume fonio.
- The first experiments in the optimization of parboiling process for producing a parboiled fonio with good technological quality.
- The achievement of engineering drawings of two driers, their local manufacture and first tests in local conditions with a processor.

The main objective of **WP2** is to determine the nutritive value of fonio and fonio products and its contribution to nutrient intake and nutritional status. Within WP2, Wageningen University (division of Human Nutrition) in Holland is working closely together with WP1 and WP6. Activities within WP2 are carried out in close collaboration with the IER in Mali and the Université d'Abomey Calavi (Department of Food Science and Nutrition), Benin.

This objective will be achieved through the following specific objectives:

1 – To analyse the nutritional value of different fonio varieties, milled fonio and diverse fonio products (pre-cooked, parboiled).
2 – To determine the role of fonio in the dietary pattern.
3 – To determine the contribution of fonio to nutrient intake and nutritional status.
4 – To determine the bioavailability of iron from fonio-based diets.
5 – To determine the bioavailability of iron from low versus high phytate content fonio diets.

Major achievements during the reporting period are:

- Successful application for extra funding of two PhD-candidates with the Dutch Government
- Literature research concerning nutrient content of fonio finalised (contribution to M 2.2. and R 2.1)
- Proposals for pilot studies developed (contribution to Milestone 2.2. and Result 2.1)
- Fieldwork of pilot studies carried out (contribution to Milestone 2.2. and Result 2.1)
- First part of training PhD-candidates completed
- Detailed proposals for sub-study 1 (nutrient value of fonio), sub-study 2 (role of fonio in dietary pattern) and sub-study 3 (contribution of fonio to nutrient intake) developed (contribution to Milestone 2.2. and Result 2.1)

WP3 led by Cirad concerns "demand for new products and its effects on income generation and distribution". WP3 contributes to the project since it provides information about the markets and the market chains of fonio products. WP3 includes first an analysis of the demand of fonio products in African cities as well as in European countries, and second an estimation of the impacts of the development of new products on the employment level and the income distribution in between stakeholders of the different market chains (old and "new"). WP3 has strong interactions with WP4 (dynamic of processing units) and WP1 (technological change) and to a less extent with WP5 (farming systems).

Activities started in March 2006 after the kick-off meeting and more effectively after the WP1-WP4 workshop in Dakar in June 2006. They consisted mainly in new surveys about quality, purchases, and about market chains. Data are being processed and results will be available in 2007.

WP4 is led by ENDA Graf (Senegal) and concerns "small scale enterprises and innovation in terms of products and processes" with the following specific objectives:

1 - Identification and typology of the SMEs involved in the process of fonio.
2 - Assessment of the different formal and informal relations between SME and their suppliers and their clients and of the internal organisation.
3 - Assessment of capacity and constraints of each type of SMEs to develop new products and process

WP4 has strong interactions with WP3 and WP1. During the reporting period, major achievement concerns the typology of fonio processing firms in Senegal.

WP5 led by Cirdes (Burkina Faso) and entitled "Opportunities of diversification and multiple uses of fonio in production systems", has five objectives:
1- Analysis of the range of fonio-based production systems and importance of fonio in the production system;
2 - Characterization of the importance of fonio in cropping systems;
3- Analysis of production and prospective strategies;
4 - Characterization of the assets and drawbacks of the socio-technical environment;
5 - Joint design of technical and organization innovations.

The year 2006 was devoted to the first objective, with a survey of 300 farmers in Guinea, Mali and Burkina Faso, evenly distributed throughout the main fonio production basins (two basins/country). The results available at the time of writing concern Burkina Faso

WP6 is led by CRAW (Belgium) and involves IRAG, IER, CIRAD and CIRDES. The aim of WP6 is to find out more about fonio-based cropping systems and look at ways of improving productivity, in line with the production chain's expectations.

Major achievements of the WP6 during the year 2006, are:

- The definition of a clear work program for the all project lasting;
- The collect and the characterisation of the production potential of a set of varieties in Guinea and in Mali;
- The definition of fonio response to abiotic factors (fertilisers, photoperiodism, …) in term of biomass production and distribution;
- The collect of agro-meteorological data;
- The identification of the zones and the performing, by the WP 5, of the diagnosis of local agroecological knowledge on fonio cultivation coupled to the identification of the main factors (varietal, agronomic, socio-economic…) that refrain development of fonio production;
- The production and the distribution of the raw material necessary to WP1 and WP2 for technological and nutritional analyses.

Cliché J.F. Cruz

Fig. 2: Fonio field near Labé in Fouta Djalon (Guinea)

Section 2 – Workpackage progress of the period

This section gives an overview of the actions carried out in the different workpackages during the reporting period.

2.1. Work package 1 - Diversification of fonio products for niche export markets and local markets

Responsible scientist: Mrs Geneviève Fliedel - Cirad (France)
Other participating contractors*:* IER (Mali) and IRAG (Guinea)

Participant n°	1	4	5
Organisation name	Cirad	IER	IRAG
Country	France	Mali	Guinea
Staff	**Mrs G. Fliedel** J. Grabulos M.Rivier C. Marouzé J.M. Méot J.F. Cruz	**D. Dramé** Mrs B.F. Guindo Mrs C.O. Traoré Mrs C. S. Sidibé	Mrs M. Ndiaye

Workpackage objectives and starting point of work at beginning of reporting period

The problem with fonio is the difficulty of the long and fastidious task of milling, a real bottleneck in its processing. After threshing, the grain is still surrounded by husks (fonio paddy) and must be processed into white fonio to become an edible food. Hulling and whitening of fonio grain is usually done by hand and requires four to five successive poundings using a pestle and a mortar, alternating with as many winnowings. Because of the extremely small size of the grain, processing of fonio is particularly tedious and time-consuming task for women: it takes nearly one hour to mill only one to two kilos of paddy fonio. Moreover, in order to obtain a quality product, all bran and sand must be eliminated by washing the grains several times, which increases processing time and effort required for preparation.

Paddy fonio Hulled fonio White fonio

Fig. 3: Different fonio forms during processing

Very recently, an international research/development project named “Improvement of post-harvest fonio technology” was carried out in West Africa and managed to develop new equipments to mechanize threshing, milling and cleaning of fonio. This project particularly focused on practical results for post-harvest technology has raised some research questions dealing with knowledge of fonio as edible seed, (proximate analysis in relation with the process, technological, cooking and nutritional qualities, ..), the necessity to elaborate specific protocols to analyse this tiny grain, the need to develop research on mechanization of specific post-harvest operations (washing and drying, …).the need to make new products with constant technological and organoleptic characteristics and higher nutritional quality. These new products are aimed to local population but, because of their dietetic properties, they will encourage the creation of niche export markets and will diversify cereal products in Europe.

The major achievements during this first year of the project were:

- The identification of quality criteria of milled and cooked fonio in Bamako by all the stakeholders that play a role all along the fonio chain and at different steps : when they buy, when they process and when they consume fonio.
- The first experiments in the optimization of parboiling process for producing a parboiled fonio with good technological quality.
- The achievement of engineering drawings of two driers, their local manufacture and first tests in local conditions with a processor.

Progress towards objectives – tasks worked on and achievements made with reference to planned objectives, identify contractors involved

2.1.1 Precising quality criteria of milled and cooked fonio (task 1.1)

The objective of task 1 in the workpackage 1 is to better understand organoleptic properties of fonio in order to develop laboratory instrumental tests for measuring the quality of new products (parboiled and precooked fonio) we will produce during this project. The different steps to reach this objective will be 1/ the identification of the quality criteria of milled and cooked fonio in the 4 countries of the project 2/ the improvement of laboratory protocols on assessment of fonio quality and 3/ the relation between instrumental tests, sensorial tests and physico chemical characteristics of the product.

During the first year of the project, this first step was realised in Mali only. It was decided in agreement with WP3, during the first WP1-WP4 meeting in Dakar - Senegal (June 2006), that the identification of the quality criteria will be done in Bamako, Mali, during 5 months through qualitative and quantitative surveys with the support of IER (LTA and Ecofil). The reasons for limiting the surveys to Bamako have been the followings: it seemed very difficult for ENDA Graf, based in Dakar, to conduct surveys in the very distant east-southern regions in Senegal where fonio is mainly grown and consumed; in Guinea no socio economist from IRAG was identified at the beginning of the project ; the proximity and similarity with Mali of the western fonio producing regions in Burkina Faso.

It was also decided that the surveys will be conducted by a Cirad student (Mrs Sandy Blancher, agro development engineer diploma) and an IER technologist with the help of Ecofil interviewers. Qualitative surveys will be done through individual interviews (open interviews and semi-structured questionnaires) and through focus groups and will be completed by sensorial tests. Quantitative surveys will be done with structured questionnaires. Relevant descriptors of the fonio quality will be collected from different types of stakeholders all along the fonio chain -those who are in contact and have a good knowledge of this cereal- not only when they sell or buy fonio, but also when they process it or consume it.

Methodology used

Individual interviews

Open interviews were conducted with 9 stakeholders (2 wholesalers, 5 processors and 1 consumer) in order to have a global view of the fonio chain, contact key persons, prepare semi structured and structured questionnaires.

Elaborated interviews were conducted with 34 stakeholders through semi structured questionnaires in order to get complete information on purchase and consumption habits:

- 6 retailers from 4 markets in Bamako : Médine, Korofina, Dibida and Magnanbougou
- 7 processors : “big” processors that have -or subcontract the use of- the GMBF dehuller machine and “small” processors that process fonio manually with mortar and pestle (some of them sell it on the Niger river bank)
- 9 restaurant cookers (expensive and cheap restaurants ; student, worker or state employee canteens)
- 12 consumers: consumers of traditional or precooked fonio at home; consumers of fonio in restaurants or canteens.

Group interviews or focus groups

Six focus groups were organized to check the list of quality traits collected through individual interviews and synthesize general data on local population behaviours. In order to avoid the emergence of leaders during the discussion, each focus group was composed of 6 persons recruited during individual interviews from a same group of stakeholders. Thus, there was successively a focus group of:

- "big" processors
- "small" processors
- restaurant (cheap and expensive) cookers
- traditional fonio consumers
- precooked fonio consumers

After a general discussion on "what is for you a good fonio when you buy it, when you process it and when you consume it" following a list of questions, the 6 persons were asked to talk about 10 different types of fonio bought from retailers during individual interviews and justify their preference :

- a fonio from Guinea 1st quality
- a fonio from Guinea 2nd quality
- a fonio from Guinea 3rd quality
- a fonio from Koutiala, Mali
- a fonio from San, Mali
- a roasted fonio from Guinea
- a milled and washed fonio from Mali
- a milled and washed fonio from Guinea
- a "new" fonio from Mali (harvested this year)
- an "old" fonio from Mali

Sensorial tests

Sensorial tests were conducted in order to have a better perception of the quality and consumer preferences. Rank tests and triangular tests were performed.

Rank tests were performed with 3 groups of 20 persons, 60 persons in total, who were asked to range five types of cooked fonio from the most preferred to the least preferred and precise for what reasons. Four different fonios (from Guinea, San, Bougouni, Dogon plateau) were first bought in the market, one of them (fonio from Guinea) was also parboiled in IER (soaked, steamed and dried). These five types of fonio were then milled with GMBF machine, washed and cooked in optimal conditions for each one (various cooking time and quantity of water added) before being served in a same plate, in same quantity and at the same tine to each person of the group.

Triangular tests were performed with the 6 persons of 5 of the 6 focus groups, 30 persons in total, in order to determine if they could differentiate two types of cooked fonio judged very close in the previous test. Three samples were presented to each person: two came from the same cooked fonio and the third one from the other. The question was: what sample is different from the two others ? There are 6 possibilities to present samples in a plate: AAB, ABA, BAA, BBA, BAB, ABB. Samples were coded. To know if there is a significant difference between the two fonios, the number of correct answers must be counted and compared to the value in the table of binomial law for a probability of 1/3.

Main results

Individual or group interviews brought out a list of quality criteria that have been named by most of the stakeholders (retailers, processors, restaurant cookers, consumers) talking about fonio purchase. These criteria concern some grain characteristics (hardness, size, colour, age, origin) but essentially the convenience for it to be subsequently processed: milling degree, absence of impurities, sand and sanitary aspect. They have been quantified through quantitative surveys: among 143 persons interviewed when buying fonio, about 70 % prefer grain with good swelling properties that swells twice of three times during cooking (it should be older and harder grain with smaller size); 65 % look for cleaner grain with lower percentage of impurities (sand, dust, stones, other grains…), 58 and 55 % want respectively a light

coloured grain almost completely milled. Grain size and hardness have less importance for fonio purchasers.

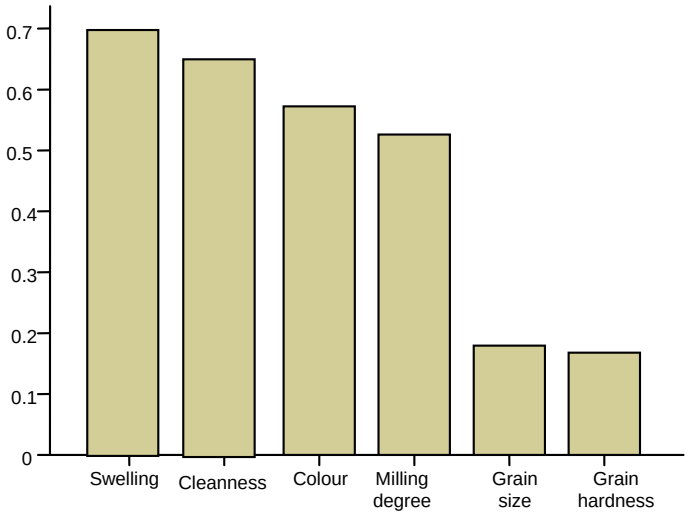


Fig. 4: Quality criteria of fonio identified through quantitative surveys in Bamako (Mali)

The same criteria have been emphasized from processors or consumers when processing fonio grain. They try to have this laborious task facilitated and shortened. They choose a cleaner, almost completely milled grain, dried with lower amount of brokens. They underlined during focus groups the importance of the expertise of the person who usually processes fonio grain.

By interviewing all the stakeholders on “what’s for you a good fonio when eating it”, gustative but also visual and olfactory criteria have been standing out, with a particular emphasize on gustative criteria. Interviewed persons prefer first a well cooked fonio, with a soft consistency (30/30), swollen, not sticky and with no sand (30/30). Grains must be individual (27/30), smooth (28/30), not rough (25/30). Visually, colour must be light (20/30), with a minimum of paddy, herbis and other impurities (26/30). A sugary (23/30) and wild (10/30) smell are well appreciated while dusty and old smell must be avoid (9/30).

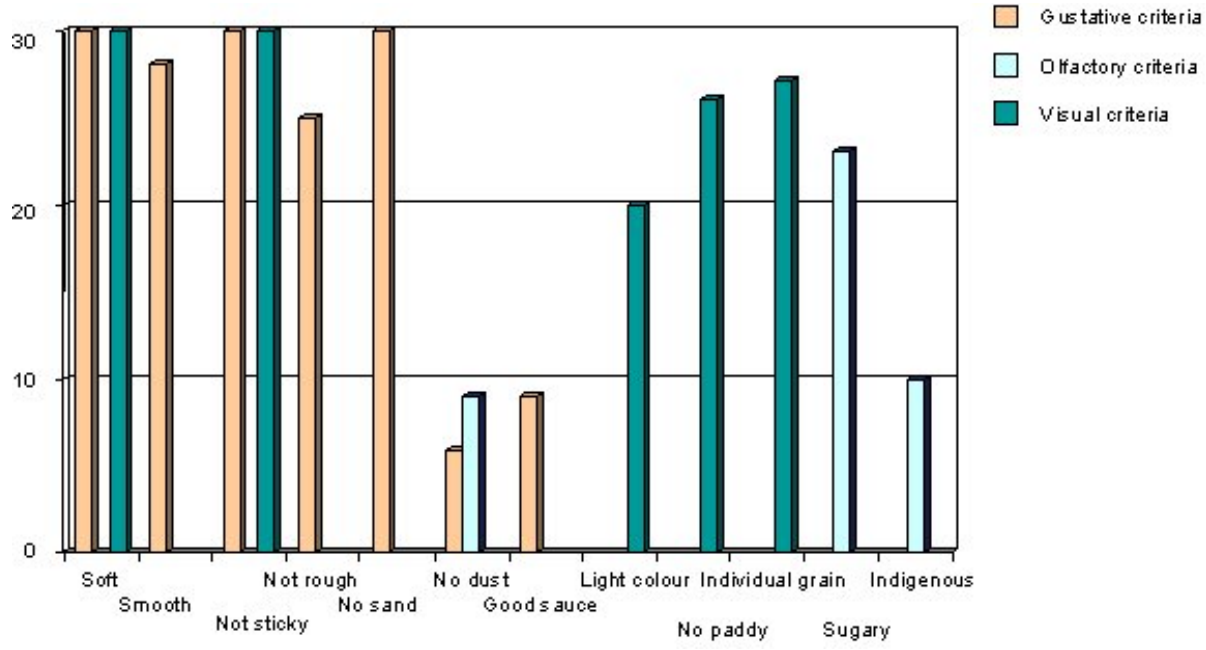


Fig 5: Quality criteria of fonio at consuming, identified from different stakeholders in Bamako (Mali)

Among the 60 persons who participated to the rank test, 2 were put aside because of their incoherent answers. Considering the 58 persons left, cooked fonios were ranked in a decreasing order of preference as followed: Bougouni, Guinea, Dogon, San and in the last position fonio from Guinea parboiled in IER. The most preferred cooked fonio were fonio from Bougouni and fonio from Guinea.

According to Friedman test and using a rank sum analysis, we found that the panel has appreciated differently the five samples and there was not a significant difference of preference between fonio from Bougouni and fonio from Guinea. These two fonios appeared very close in the ranking.

Fonio	Rank Sum	Groups		
Bougouni	101	**A**		
Guinea	120	**A**		
Dogon	191		B	
San	208		B	C
Parboiled	250			C

Table 1: Rank sum analysis for the five fonios

By looking at the percentage table, we noticed that when fonio from Bougouni came first, fonio from Guinea came in second position at 79.3 %, and on the other way, when fonio from Guinea came first, that is fonio from Bougouni which arrived just after at 71.4 %.

2nd	1st	Bougouni	Guinea	Total
Bougouni			**71.4 %**	
Guinea		**79.3 %**		
Dogon		17.2 %	9.5 %	
San		3.4 %	14.3 %	
Parboiled at IER			4.8 %	
Number of persons		29	21	58

Table 2: Comparison between 1st and 2nd position in the five fonio rank

At the question “For what reasons do you prefer this fonio”, the most frequently criteria named were first colour and taste then consistency ; grain size, smell and cleanness arriving quite after. Colour was named as the first criteria at 50 %, taste at 25.9 % and consistency at 15.5%. According to a group of 6 processors, a good fonio” has a white or clear colour, a sweet taste and a soft consistency. Parboiled fonio was rejected mainly because of its darker colour.

Criteria	Number of criteria citations	1st criteria	
		Frequency	%
Colour	**52**	29	**50.0**
Taste	**52**	15	**25.9**
Consistency	**43**	9	**15.5**
Size	15	3	5.2
Smell	25	1	1.7
Cleanness	8	1	1.7

Table 3: Number of citations per criteria and as 1st criteria

After eliminating 6 persons from the consumer group who did not understand the question (problem of translation), the results of triangular test on the two most preferred fonios showed that 13 answers on 24

were correct. A good answer can be given at random and the probability to get it is 1/3. Using the binomial distribution, the probability to obtain 13 correct answers out of 24 is lower than 5 %, that means that these two fonios are perceived as different.

Total of answers	Correct answers	p	q	Probability (%)	Cumul (%)
24	**13**	0.33	0.67	1.81	**2.84**
24	14	0.33	0.67	0.71	1.03
24	15	0.33	0.67	0.24	0.32

Table 4: Probability to obtain correct answers using a binomial law B (n, 1/3)

The criteria such as colour, consistency and taste will be taken into account in the improvement of laboratory protocols for measuring fonio grain quality.

A similar approach should be applied partly in Guinea during the second year, if local conditions could be safety enough.

2.1.2. Producing precooked and parboiled fonio products with constant and improved technological, organoleptic and nutritional qualities (task 1.2)

The objective of task 1.2 is to develop precooked or parboiled fonio products for local markets or for export. The different steps to reach this objective are

- The analyse of the behaviour of fonio paddy grain, fonio whole grain or fonio white grain during cooking, precooking or parboiling in order to better understand the evolution of the grain with the thermal treatment.
- The analyse of starch characteristics (gelatinisation properties, development of complexes with lipids), texture properties (swelling properties, grain consistency) and mechanical properties (hulling and milling properties).
- The identification of existing processes and equipments with the support of WP4.
- The optimization of processes for making precooked and parboiled fonio products with good technological quality.

During this reporting period, the 3 first steps of task 1.2 have started. Experiments in fonio parboiling at laboratory level have started by a study of paddy grain behaviour during soaking in water at different temperatures.

Paddy grain behaviour during soaking in water at different temperatures

A water bath with a control of temperature was used. Paddy grains were introduced into nylon socks and plunged into water at constant temperature (from 18 to 45°C) during various periods (from 0 to 24h), more frequently during the first four hours. When removed out of water, soaked grains were centrifuged at 2000 rpm in specific plastic pots separated in two parts by a metallic screen for draining off water in the lower part. The quantity of water absorbed by paddy grains during each soaking period was measured at each temperature.

We have shown that it increased rapidly during the first minutes and till 4 hours of soaking before reaching a plateau at about 36 % w.b. of grain water content. We have shown also that water is absorbed by fonio grain -assimilated to a sphere- following a diffusion phenomenon. Diffusion coefficients, calculated using a graphic method or a resolution method with Excel, varied with water temperature from 1.10^{-12} (at 20°C) to $3.6.10^{-12}$ (at 45°C).

The kinetics of water absorption will be useful to predict soaking period and temperature to reach a chosen paddy grain water content.

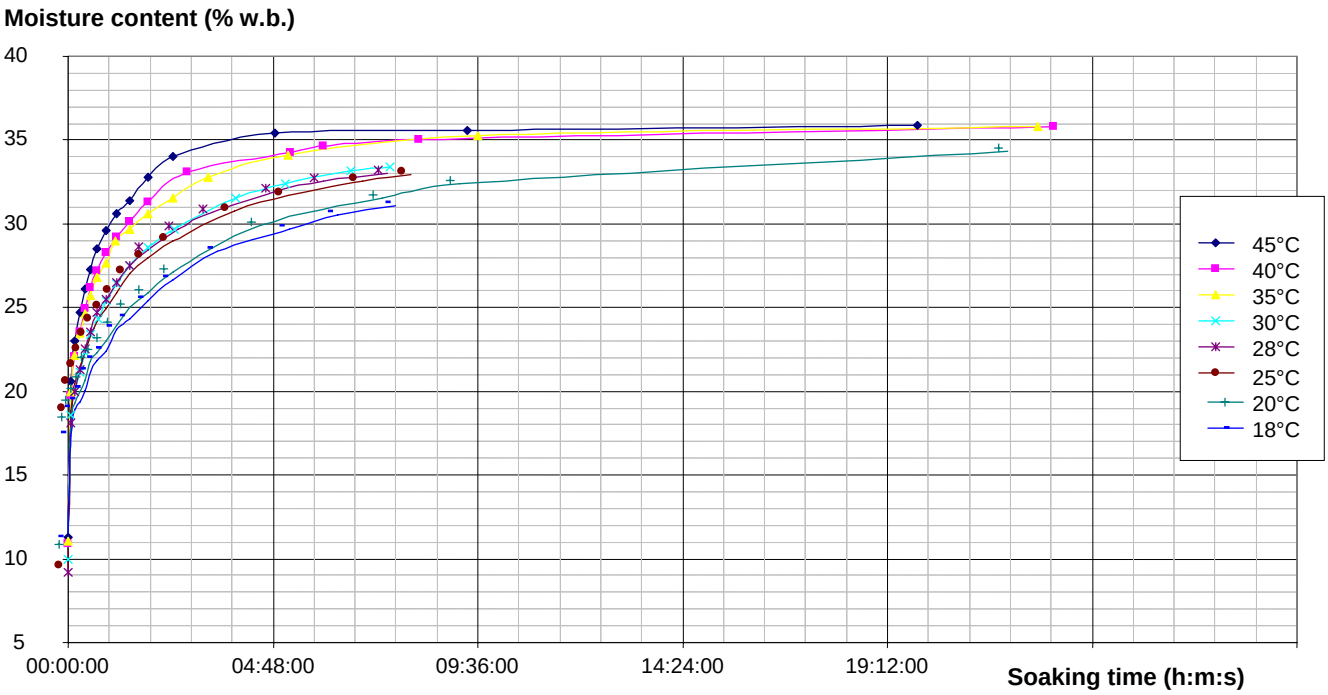


Fig. 6: Water absorption curves for paddy fonio at different temperatures

Determination of minimum grain water content for starch gelatinisation

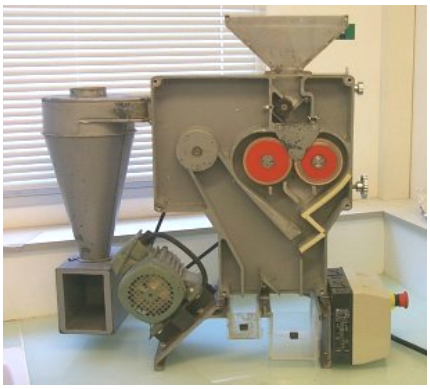
A Differential Scanning Calorimeter was used to predict parboiling conditions (minimum grain moisture content and steaming temperature) to get a parboiled fonio, partially or totally gelatinized, with or without complexation between lipids and amylose. This equipment (Perkin Limer DSC7) using hermetic stainless steel pans, measures enthalpy differences between a sample and a reference submitted to linear heating and cooling cycles. The pan containing the sample (15-20 mg of ground fonio grain with pure water) and the pan containing the reference (50 µl of pure water) were heated from 25°C to 160°C at 10°C/min, held at 160°C for 2 min and cooled from 160°C to 35°C at 10°C/min.

The effect of increasing quantity of added water on starch gelatinization in ground paddy grains was studied. 2 to 10 µl of pure water were added to 19-20 mg of ground grains resulting in a variation of grain moisture content from 20 to 35 % w.b. When water in excess (50 µl) was added to fonio flour, temperature of gelatinization peak was observed at 75.5°C. In presence of limited quantity of water, starch gelatinization peak moved to higher temperature (for example, 135°C at 21 % of water, 110°C at 28.7 % of water). It seemed that at 31.5 % minimum, it recovered nearly its initial place at 81.5°C. Another peak was observed at about 110°C that should represent fonio starch melting.

These experiments showed that the minimum water content of fonio grain after soaking should be 31 % w.b. and by reporting this value on kinetic of water absorption at 40°C for instance, we found that fonio paddy grains should be soak during 1 h 50 to reach this moisture content and be parboiled with a starch gelatinization during steaming treatment.

Paddy grain behaviour during parboiling

A laboratory autoclave of 20 cm of diameter and 10 l of capacity heated by a hotplate was used. A support of four metallic superposed screens (710 µm openings), adapted to this pressure cooker, was made in Cirad engineering work. Soaked paddy grains were displayed on two layers on each screen (about 30 g of grain per screen) with 200 ml of water in the bottom under the lower screen. After steaming, paddy grain was dried at ambient temperature then hulled with a laboratory Satake Rice Machine dehuller adapted to fonio, milled in an abrasive plate rice mill also adapted to fonio and washed to remove bran and sand.



Rubber rolls huller

Clichés: J. Grabulos

Stone whitener

Autoclave for fonio parboiling

Fig. 7: Laboratory equipments

After soaking the fonio paddy grain in water at 40°C during 1h50 with the view of reaching 31 % w.b. of moisture content, steaming was carried out in the autoclave at 120°C under pressure of 2 bars during three periods (3, 10 and 30 min). This temperature was chosen to favour starch gelatinization and also lipid-amylose complex melting, especially for a longer period, with the aim of reducing the stickiness of cooked grain. Differential scanning calorimetry analyses confirmed that after 30 min of steaming starch was completely gelatinized and almost even after 3 min (no peak visible at 75-80°C compared to raw grain). A peak corresponding to the melting of complexes formed during parboiling appeared at about 110-120°C.

Concerning milling properties, hulling yields seemed to be close to those of raw grain with around 75 % but whitening yields obtained were 96-97 %.(compared to 90 % with raw grains) with lower percentage of brokens (0.1 % compared to 1.2 % with raw grains). These results should be confirmed through the other experiments in progress. In addition, parboiled grain got a browner colour and as in the case of rice, the longer the steaming period the browner the grain. However, cooking lightened grain colour.

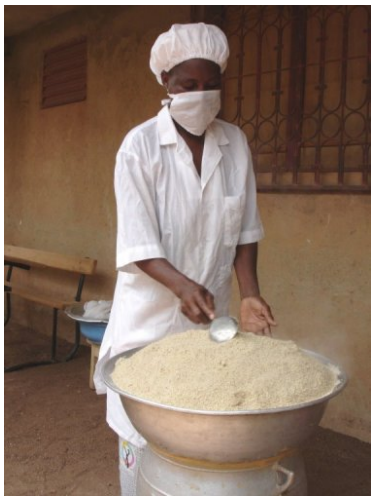
First experiments on cooking properties showed no difference between raw and parboiled fonio grain concerning swelling and consistency of cooked grain; however grain stickiness seemed to be clearly reduced. These results must to be confirmed in parallel with the improvement of laboratory protocols.

Other experiments are in progress on paddy grain, whole grain and milled grain to optimize parboiling and precooking processes.

Precooking of fonio at MSE level

Precooking of fonio at MSE level (trademark “tout super”) was observed in Ouagadougou (Burkina Faso) during a mission in June 2006. It was thus possible to make a first identification of the traditional processes of precooking used by the processing women (tools use, mode of preparation, power consumption, …)

Perforated pan for precooking



Fonio precooking

Clichés: J.F. Cruz

Drying of precooked fonio on tray

Fig. 8: Precooking at small enterprise level

2.1.3. Developing equipments adapted for washing and drying fonio grain and products (task 1.3)

The objective of task 3 in the workpackage 1 is to continue the mechanization of post harvest technologies in order to facilitate women labour.

During the first year of the project, this activity was focused on drying. 2 types of driers were manufactured: a counter current cross-flow drier and a greenhouse ventilated solar drier. The principles of these equipments have been already studied during a previous project (CFC FIGG/02).

The activities of this task achieved during this reporting period were the followings:

- to complete theoretical approach for sizing the two driers
- to study a local manufacture
- to draw the driers and control their manufacture
- to carry out experiments with them in local conditions and achieve their performances in view of a future distribution

Counter current cross-flow drier

Principles of the drier:

The principle of this SFT drier ("Séchoir à Flux Traversant") is to produce a counter current flow between hot air flow going from bottom to top and the product which is transferred on trays from up (position 4) to down (position 1). Hot air flow goes through the product mass and facilitates the exchange air-product.

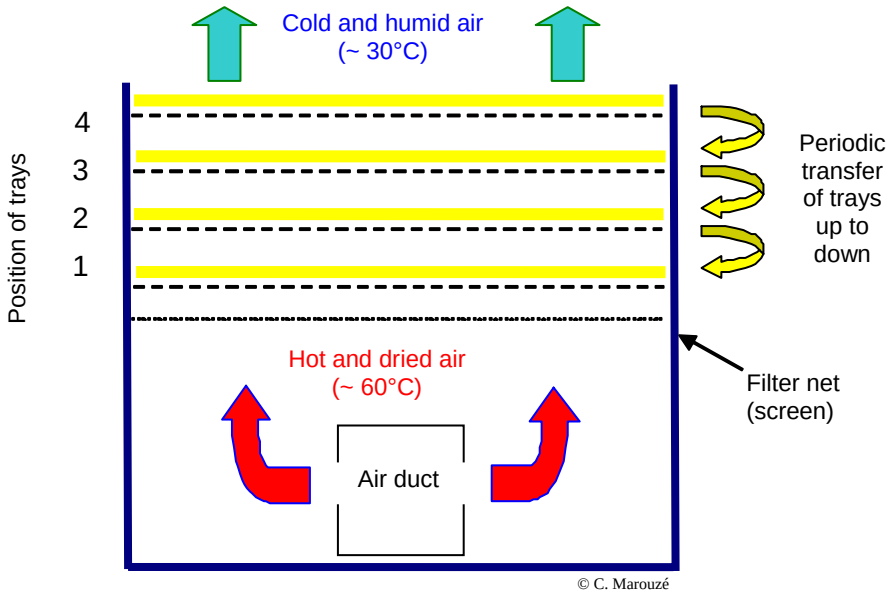


Fig. 9: Schema of the cross flow drier SFT

This drier comprises an air heater using a gas burner, an air ventilator mounted on the axis of an electric engine, and 3 sections, each one composed of 4 perforated stacked trays, which represent an enclosure of exchange between hot air and the product. Trays are rectangular drawers which are introduced or extracted horizontally into or out of the drier. Each section is closed by a door. Hot air is introduced by a metal air duct under the trays, covering all the 3 sections. It is distributed homogenously all through the tray because of the pressure losses created by the product. The product is put on a net which is very useful to remove it or mix it.

Achievement of drawings and local manufacture

Drier drawings were achieved for a local manufacture in wood with a brick base and a ventilator engine of 1500 rpm to have an air speed of 0.17- 0.30 m/s. The drier was manufactured by Mod-Engineering in Bamako followed by several modifications and adjustments.

Cliché J.F. Cruz

Fig.10: The cross flow drier SFT in IER Centre of Sotuba (Mali)

Experiments

The experiments carried out with this equipment were satisfactory in term of capacity, drying speed (time), dried product quality, ergonomics and manufacture costs. These counter current flow and cross flow result in a good efficiency in energy with consequently a lower gas consumption. Compared to other driers available in the region, there is an additional cost of electricity but it is lower then gas saving cost. Experiments must be replicated to confirm these results and must be conducted during humid season. A fonio processor present during the drying of her product has been satisfied by its quality.

Greenhouse ventilated solar drier

It was developed first to protect the product against bad weather, birds, dust and second to reduce frequent handlings.

Principles of the drier

This drier is a solar drier with forced convection. Drying is obtained by direct sun radiance on the product combined with a greenhouse effect. Temperature is higher inside the greenhouse than outside and drying is achieved at low temperature by using sun radiance for heating the air and the product. Ventilation provides a constant extraction of the air, moistened by the product water evaporation, and drying is improved because of the presence of several ventilators that mix the air inside the greenhouse and improve the exchange between air and product.

Achievement of drawings and local manufacture

A greenhouse drier is composed by a galvanized tube structure covered with a plastic film. 2 ventilators, in the rear, blow out continuously inside air. A bigger one blows directly the product during the day and 2 others on the ceiling mix the air. In the front, there are a door and 2 air entrances protected from dust by a mosquito screen doubled with a canvas. The product is spread on a cloth on several tables.

Clichés: C. Marouzé

Fig 11: Outside and inside views of the greenhouse solar drier tested in Bamako

Experiments

The experiments carried out with this equipment were satisfactory in term of drying time, final moisture content and product quantity dried per day. It is necessary to continue experiments to optimize ventilator air flow, drying capacity and drying periods of the product on trays. Utilization cost of this drier was CFAF 24/kg of dried fonio and represent less than 4 % of sale cost of precooked fonio ; it is lower than that of others driers.

The advantages of this drier are 1/ a continuous mixing and extraction of the air 2/ a lower cost in energy 3/ a only one day drying 4/ drying cereals as flour, pasta, couscous, whole grains 4/ possibility to increase drier capacity with several units depending of processor need.

2.1.4. Characterizing different fonio varieties at physical, technological level and identifying the varieties the most adapted to mechanical processing (task 1.4)

The objective of task 1.4 in the workpackage 1 is to identify fonio varieties the most adapted to a mechanical processing (milling, precooking, parboiling) and look at the effect of cropping system on their physical, biochemical and technological characteristics.

This study will really start in the second year of the project since all the samples of fonio ecotypes have been just provided by WP6 and WP5. 15 varieties from Mali and 13 from two different experimental stations in Guinea have just been sent by WP6, in total 41 varieties. A collection of local varieties bought directly at farmers' in Mali, Guinea, Burkina Faso will be sent sooner by WP6, more precisely 3 varieties (early, intermediate and late) per village, in 4 villages per country, in total 36 varieties.

All of these varieties will be characterized at physical and biochemical level. Their hulling and milling properties will be compared and their cooking and organoleptic properties will be determined.

Deviations from the project workprogramme, and corrective actions taken/suggested: identify the nature and the reason for the problem, identify contractors involved

The activities in WP1 have really started after the first WP1-WP4 workshop (held in June 2006 in Dakar) where they have been planned with all the participants. That is the reason that some deliverables have been delayed (see tables below).

Presently, the only deviation in the work programme has been in task 1.1 where the identification of quality criteria of milled and cooked fonio was achieved only in Mali and not in the four countries of the project. The reasons have been explained in the paragraph workpackage progress in the period (task 1.1). This activity should be partly conducted in Guinea during the second year of the project since a socio economist was identified by IRAG and if local conditions would be better.

List of deliverables, including due date and actual/foreseen submission date

Del N°.	Deliverable name	WP N°.	Date due	Actual/ Forecast delivery date	Estimated indicative person-months *)	Used indicative person-months *)	Lead contractor
1	Synthesis on quality criteria of cooked fonio and consumer preferences	1	12	15	2		Cirad
2	Laboratory protocols on assessment of cooking quality	1	24	21	3		Cirad
3	Paper on the relation between sensorial tests, instrumental tests and physico-chemical characteristics of fonio	1	24	33	2		Cirad
4	Paper on physical and mechanical properties of fonio grain as well as starch and rheological properties of cooked fonio	1	22	33	2		Cirad
5	Equipments for washing, cooking and drying developed and validated in local enterprises	1	30	33	6		Cirad
6	Manufacture drawings of equipments for drying, cooking, washing, available	1	33	32	2	1	Cirad
7	Report on acceptability tests of parboiled and precooked fonio products by local and European populations	1	24	33	2		Cirad
8	Booklet addressed to processors for producing high quality products for exports	1	30	30	2		Cirad
9	List of fonio ecotypes with good agronomic and technological qualities, adapted to mechanical processing	1	33	33	6		Cirad

List of milestones, including due date and actual/foreseen achievement date

Milestone no.	Milestone name	WP n°.	Date due	Actual/Forecast delivery date	Lead contractor
M1.1.	Start up workshop to define concerted approaches for WPs	1	1	Done in March 06	Cirad
M1.2.	Quality criteria and consumer preferences of cooked fonio identified.	1	12	15 (in Mali)	Cirad
M1.3.	Ventilated solar dryer built, month 12, and tested, month 21.	1	12, 21	Done in Dec 06 Scheduled 21	Cirad
M1.4.	Physical and mechanical properties of fonio grain and starch and rheological properties of cooked fonio determined.	1	18	30	Cirad
M1.5.	Relevant process and equipment principles for precooking and parboiling identified.	1	24	24	Cirad
M1.6.	Acceptability tests of the new products with local and European people performed, month 30.	1	30	30	Cirad
M1.7.	Equipment of washing, cooking, parboiling manufactured, month 24, and tested, month 30	1	24,30	30,32	Cirad
M1.8.	Physical, biochemical, technological and organoleptic characteristics of widely used ecotypes determined.	1	30	30	Cirad
M1.9.	Quality norms of new products proposed.	1	30	30	Cirad

2.2. Work package 2 - Nutritional aspects of fonio and fonio products

Responsible scientist: Mrs Inge Brouwer - Wageningen University (The Netherlands)
Other participating contractors*:* IER (Mali), Cirad (France) and Cirdes (Burkina Faso)
Other collaborator*:* Université d'Abomey Calavi (Benin)

Workpackage objectives and starting point of work at beginning of reporting period

The general objective of WP2 is to determine the nutritive value of fonio and fonio products and its contribution to nutrient intake and nutritional status. This objective will be achieved through the following specific objectives:

1 – To analyse the nutritional value of different fonio varieties, milled fonio and diverse fonio products (pre-cooked, parboiled).
2 – To determine the role of fonio in the dietary pattern.
3 – To determine the contribution of fonio to nutrient intake and nutritional status.
4 – To determine the bioavailability of iron from fonio-based diets.
5 – To determine the bioavailability of iron from low versus high phytate content fonio diets.

Staff of the Wageningen University (division of Human Nutrition) is leading the Working Package 2: Nutritional aspects of fonio and fonio products, and has therefore the overall scientific and technical responsibility for the supervision of (1) the implementation of the proposed studies, (2) the data collection, analyses and interpretation, and (3) the reporting of the results, for those parts of the studies which concern the nutritional quality of fonio and fonio-products and the nutritional role fonio plays and may play in an healthy daily diet for especially West-African people.

Researchers from WP2 will generate knowledge on the nutritional aspects of fonio varieties and fonio products. This will be done in five sub-studies. In sub-study 1 the content of minerals, amino acids, vitamins, fatty acids and fibre will be determined through chemical analysis. The fonio varieties and fonio products to be analyzed will be determined in close collaboration with WP1 and WP6. In sub-study 2 through food consumption and food ethnographic studies (the last in collaboration with WP3) the role of fonio in the diet will be established in association with the socio-economic status of the study population. Based on the food consumption study, the contribution of fonio to nutrient adequacy will be determined in sub-study 3. Anthropometric measurement and blood analysis will be used to determine the nutrition status of the study population. Researchers in WP2 will identify the effect of socioeconomic status on fonio consumption and the association with nutritional status of the study population. Through sub-study 4, an intervention study, the bioavailability of iron from fonio will be determined using fonio-based diets labelled with the stable isotope ^{58}Fe. A second intervention study, sub-study 5, will determine whether the use of a low phytate fonio variety in the diet will improve the iron bioavailability compared to the use of a high phytate fonio variety. Also, the extent of the improvement of iron bioavailability through the use of low phytate fonio variety will be compared to the use of ascorbic acid during food consumption. This will be studied in a so-called two-by-two design, where the study population will be randomly allocated to two groups, receiving low or high phytate fonio-based diets. Within each group, half will receive ascorbic acid and the other half will receive a placebo.

Within WP2, Wageningen University is working closely together with WP1 and WP6. Activities within WP2 are carried out in close collaboration with the IER, Mali (partner 4) and the Université d'Abomey Calavi (Department of Food Science and Nutrition), Benin. Both from IER and UAC, a PhD student is involved in the design, implementation, analysis and reporting of the different sub-studies. The PhD-students are enrolled in the Wageningen University Sandwich PhD-programme and are supposed to graduate in 2010.

Progress towards objectives – tasks worked on and achievements made with reference to planned objectives, identify contractors involved

Major achievements during the reporting period are:

- Successful application for extra funding of two PhD-candidates with the Dutch Government
- Literature research concerning nutrient content of fonio finalised (contribution to M2.2. and R2.1)
- Proposals for pilot studies developed (contribution to M2.2. and R2.1)
- Fieldwork of pilot studies carried out (contribution to M2.2. and R2.1.)
- First part of training PhD-candidates completed
- Detailed proposals for sub-study 1 (nutrient value of fonio), sub-study 2 (role of fonio in dietary pattern) and sub-study 3 (contribution of fonio to nutrient intake) developed (contribution to M2.2 and R2.1.)

Activities of WP2 in 2006 mainly focussed on task 2.1 (nutritional value of fonio and fonio products), task 2.2 (the role of fonio in the dietary pattern) and task 2.3 (contribution of fonio to nutrient intake and status)

Preamble
The activities within WP2 are carried out with two PhD fellows; one from IER, Mali (Mrs. Yara Koreissi) and one from UAC, Benin (Mrs. Nadia Fanou). Both candidates are enrolled in the Sandwich PhD Programme of Graduate School VLAG of the Wageningen University. Sandwich PhD students are international PhD candidates who are not employed by Wageningen University but have a grant and in general only spend the initial and last 6-8 months of the 4-year PhD Programme in Wageningen. The first period is spent elaborating on the proposal, studying literature and following courses, while the last period is spent finishing the thesis. In the intermediate period the PhD candidate performs her research in the country of origin. These PhD candidates need to have the support of both their home institute and supervisor at Wageningen University. The actual research takes place in the PhD candidate's own country under local supervision. During this period, contact with the supervisor in Wageningen is by e-mail and annual visits. Concerning the candidate from Benin, research will take place in Mali supervised by the supervisor in Wageningen (Wp2-leader) and a supervisor from UAC, Benin (Dr. Romain Dossa).

PhD training
As part of the PhD programme of the two PhD fellows involved in the study, training took place at the Division of Human Nutrition of Wageningen University from September till December 2006. The candidates attended several courses including extensive training on food consumption studies and data analysis, advanced statistics, information literary, and they attended the Graduate School VLAG PhD-week where they presented their study proposals. During the training period, the candidates also developed detailed proposals, workplan and budget for the studies related to task 2.1, 2.2 and 2.3. These were extensively discussed with staff of the Division of Human Nutrition.

2.2.1. Nutritional value of different fonio and fonio products (Task 2.1)

Based on previous work of researchers involved in WP2, a standardized procedure for fonio processing was developed.
A quality assessment was carried out concerning iron and zinc analysis of fonio in Mali. Samples with an known level of iron and zinc were sent from the laboratory of the Division of Human Nutrition to the laboratory used by IER for analysis. Unfortunately it appeared that the iron content as measured in Mali was about 5 times higher (probably due to a.o. environmental contamination) and the level of zinc was 3 times smaller than the certified values. Based on these results it was decided to carry out the chemical analysis in the laboratory in Wageningen.

Under task 2.1 three (3) sub-sties were carried out. The first sub-study focussed on determination of the variation in nutrient content of different fonio varieties. Five (5) varieties of fonio and one (1) parboiled version of fonio were selected and bought on the market. These fonio varieties were processed following the developed standardized procedures and laboratory samples were taken from the mid-wet fonio. Chemical analysis was carried out for moisture, ash, macronutrients, minerals, phytate and flavonoids. Although at the time of writing of this report not all data were available, the results of this first analysis are given in Table 5.

	Moisture	Fat	Protein	Fibre	CHO	Iron	Zinc
Var 1	33.1	1.6	5.0	1.1	58.7	1.6	2.2
Var 2	29.5	1.5	6.2	1.6	60.8	1.7	1.7
Var 3	29.1	1.7	5.8	1.1	61.9	1.2	1.3
Var 4	29.3	2.2	4.9	1.0	62.3	1.3	1.9
Var 5	30.1	1.7	5.5	1.2	61.2	0.8	0.9
Var 6 (PB)	50.5	1.2 (1.7)	4.8 (6.7)	2.3(3.2)	40.9 (57.6)	1.4	1.4
Average (excl PB)	30.2	1.7	5.5	1.2	60.9	1.3	1.6

Var=variety; PB=parboiled version; value between brackets corrected for moisture content; iron and zinc based on dry matter

Table 5:Variation in nutrient content of fonio varieties (g/100 gram edible portion)

Table 5 indicates that variation in nutrient content between different varieties is not very high. The parboiled version showed higher content in fibre level and a slightly higher content in protein. However, the varieties were bought at the market and it is unknown whether these are pure varieties or already mixtures of different varieties.

The second sub-study focussed on the effect of women skills on nutrient content of fonio and fonio products. For this sub-study one (1) variety of fonio was bought at the market and 1 kg of this fonio was given to five (5) different women. These women were asked to process the fonio in the traditional way as they are used to, using tap-water. Laboratory samples were taken from mid-wet fonio and cooked fonio. Chemical analysis was carried out for iron, zinc and phytate levels (table 6). Unfortunately, during the time of writing this report, data on phytate were not yet available.

	Iron (mg/100 gram)[1]		Zinc (mg/100 gram) [1]	
	Mid-wet	Cooked	Mid-wet	Cooked
Women 1	1.6	2.2	2.2	3.3
Women 2	1.1	1.6	1.4	2.1
Women 3	1.6	1.6	2.3	2.1
Women 4	1.0	1.5	2.1	2.5
Women 5	1.3	1.9	2.3	2.1
Average	1.1	1.5	1.7	2.0

[1] based on dry matter

Table 6: Effect of women's skills on nutrient content of fonio

Table 6 indicates that there is only a slight difference in nutrient content between different women. Hence, the effect of processing skills is probably negligible.

The third sub-study focussed on the effect of processing on fonio nutrient content. Two (2) varieties of fonio (Dogon and Guinea) and one (1) parboiled version were selected. The standard processing procedure was used to process the fonio. Laboratory samples were taken from paddy (whole) fonio, pre-decorticated fonio, milled fonio, mid-wet fonio, dried fonio and pre-cooked fonio. Chemical analysis was carried out on iron, zinc and phytate content (Table 7). Unfortunately, during the time of writing this report, data on phytate were not yet available.

	Iron (mg/100 gram)1			Zinc (mg/100 gram) 1		
	Dogon	Guinea	Parboiled	Dogon	Guinea	Parboiled
Paddy	na	355.6	6.3	na	2.3	2.8
Pre-decort	7.6	107.3	5.0	3.0	2.2	2.3
Milled	8.7	65.1	2.5	2.9	2.1	2.1
Mid-wet	0.7	2.7	5.9	2.3	1.9	6.3
Dried	2.7	2.3	2.1	1.4	4.3	2.8
Pre-cooked	1.6	2.3	2.3	3.5	2.0	2.3

[1] based on dry matter na=not available

Table 7: Effect of processing on nutrient content

Table 7 shows that especially the paddy (whole) fonio, pre-decorticated fonio and milled fonio contain high levels of iron. This is probably due to contamination of the samples with soil. The high values are not visible in the parboiled version. At the mid-wet level, the differences between the varieties mainly disappear. Zinc level is hardly affected by contamination. Main losses of both iron and zinc take place in the cleaning process. Reasons for higher levels of zinc and iron in the dried and pre-cooked fonio are not yet understood.

2.2.2. The role of fonio in the dietary pattern (Task 2.2.) and. Contribution of fonio to nutrients intake and nutritional status (Task 2.3)

A second pilot study was carried out to prepare detailed studies within task 2.2 and 2.3. The study was carried out in 6 communes in Bamako, covering 16 quarters. Key-informants (n=15), food vendors (n=15 streetfood vendors in restaurants, n=25 streetfood vendors at road side) and food preparers in the households (n=30) were involved. Research methods used were a literature review, free listing, market surveys and household observations. A descriptive analysis of the Mali food composition table was made.

Concerning the Mali food composition table, it appeared that in the existing food composition table data were missing on type of fonio product analysed (whether paddy, milled, precooked fonio, variety). In the Mali food composition table and other literature, iron content of fonio ranged from 8.5-310 mg/100 gram edible portion. The Mali food composition table did not show data on zinc, phytate and polyphenol content of foods and of fonio. In literature, zinc levels of fonio ranged from 3-4.7 mg/100 gram edible portion.

A extensive list of foods sold at markets in Bamako was made, including units sold, weight and prices. All foods can be found at the markets throughout the year (including fonio). Prices vary according to availability, mostly depending on season of the year. Fonio is found as hulled fonio (fini fololé), whitened fonio (fini sampalé), white fonio (fini djéma). Paddy grain (fini kama) can be purchased only in rural areas.

The meal patterns of households in Bamako in general consisted of 3 meals a day, complemented with snacks. Number of meals reduces to 2 in the lean season. Those who prepare the food are the house wives assisted by their young daughters and/or servants. Communal shared plate eating is practised. At breakfast, most household members dp use their own plate/bowl. At lunch, household members eat food in groups, sharing plates/bowls in a group; the household head eats on his own; women eat with their young children; other men and boys eat together; and young girls eat together from one plate/bowl. During dinner the eating groups are comparable to those during lunch, but the household head often joins the group of men and boys. The left-overs of the meal are given to beggars or kept for the breakfast of the next day. Breakfast is served between 6:30 and 10:00 am and consists generally of millet/maize porridge, bread with omelettes and margarine, or the left-over of the day before. Lunch is served from 12:30 to 14:00 pm and comprises a staple food (cereals, including rice) and a soup. Dinner takes place between 19:00 and 21:00 pm and consists of a staple food (cereals incl. rice, yam/cassava/potatoes with or without oil, beans) and a soup.

During the household observations, only one household consumed fonio (fonio couscous, foyo, with tomato soup). Households indicate that at most fonio is prepared 3-5 times a year. In restaurants/streetfoods, fonio is always available to be served.

An extensive list of household utensils used in meal preparation and consumption is made including the local names, uses, weight and volume.

Deviations from the project workprogramme, and corrective actions taken/suggested: identify the nature and the reason for the problem, identify contractors involved

Unfortunately, the results of the quality assessment of zinc and iron analysis of fonio in Mali indicated that the analysis of the samples had to be done in The Netherlands. This will increase the budget needed for the chemical analysis. Additional funding needs to be solicited for. Also, the transportation of especially prepared fonio to The Netherlands may encounter problems at the customs in Mali.

The IER does not have a budget for field studies within Working Package 2. Therefore, part of the budget of Wageningen University needed to be transferred to IER.

List of deliverables, including due date and actual/foreseen submission date

Del N°.	Deliverable name	WP N°.	Date due	Actual/ Forecast delivery date	Estimated indicative person-months *)	Used indicative person-months *)	Lead contractor
10	Report on nutritive values of fonio varieties, milled fonio and fonio products	2	27	27			WUR
11	Paper on importance of fonio in the dietary pattern and the relationship with socio-economic status	2	21	21			WUR
12	Paper on the relationship between fonio consumption, nutrition adequacy and nutrition status	2	24	24			WUR
13	Report on methodology for the measurement and reproducibility of Fe bioavailability using stable isotope technique	2	30	30			WUR
14	Paper on the Fe bioavailability of from usual fonio-based diets	2	36	36			WUR
15	Paper on the effect of (new) processing techniques of fonio on Fe bioavailability	2	36	36			WUR
16	Paper on effect of ascorbic acid on Fe bioavailability of low versus high phytate content fonio products	2	36	36			WUR

List of milestones, including due date and actual/foreseen achievement date

Milestone no.	Milestone name	WP n°.	Date due	Actual/Forecast delivery date	Lead contractor
M2.1.	Start up workshop to define concerted approaches for WPs	1	1	Done in March 06	Cirad
M2.2.	Updated food composition table especially concerning fonio varieties, milled fonio and fonio products,.	1	12, 27	Done partly in Dec06 Scheduled 27	WUR
M2.3.	Important role of fonio in dietary pattern and reasonable contribution of fonio to nutrient intake established.	1	24	Scheduled 24	WUR
M2.4.	Methodology for measuring Fe bioavailability using stable isotope technique established	1	18	18	WUR
M2.5.	Lowering effect of processing techniques of fonio on phytate content and increasing effect on Fe bioavailability established	1	36	36	WUR
M2.6.	Effectiveness of improving Fe bioavailability of processing techniques compared to that of ascorbic acid established.	1	36	36	WUR

2.3. Work package 3 - The demand for new products and its effects on income generation and distribution

Responsible scientist: Mrs Sandrine Dury – Cirad (France)
Other participating contractors*:* ENDA Graf (Senegal), IER (Mali) and IRAG (Guinea)

Participant n°	1	4	5	7
Organisation name	Cirad	IER	IRAG	ENDA Graf
Country	France	Mali	Guinea	Senegal
Staff	**Mrs S. Dury** N. Bricas	L. Diakité M. Traoré Mrs B.F. Guindo	Mrs M. Ndiaye	B. Touré O. Gueye Mrs F. Ndoye P. Seck

Workpackage objectives and starting point of work at beginning of reporting period

The general objective of WP3 is to assess the drivers and the characteristics of the demand for innovative products from African and export markets and to understand the effect on income generation and distribution of the development of these products in comparison with the old ones.

The specific objectives are the following
- On African markets, to understand how innovative fonio products are accepted by the consumers. Identify the key factors (variables) and measure their specific effect on the demand and on the decision of purchase.
- On European markets, to identify and rank the consumers' expectations regarding fonio products. Evaluate the willingness to pay for fonio products.
- To assess the generation and the distribution of incomes by different existing innovative products, and to estimate the possible impact of the development of new products on income distribution among the different stakeholders of the market chain.

In West Africa and mainly in Mali and Burkina, small enterprises produce and sell whitened and/or pre-cooked fonio packed in sealed plastic bags. The price is still high because of high costs of processing. This constitutes a constraint for consumption but little is known about the consumers' attitude towards the other characteristics of these innovative products. No quantitative estimation of the willingness to pay for these different characteristics is available yet. This is however important to design the products, processes and organisation that will fit the best with the consumers expectations.

Progress towards objectives – tasks worked on and achievements made with reference to planned objectives, identify contractors involved

Activities started in March 2006 after the kick-off meeting and more effectively after the WP1-WP4 workshop in Dakar in June 2006. They consisted mainly in new surveys about quality, purchases, and about market chains

2.3.1. Evaluation of the demand of new fonio products in African markets (task 3. 1)

In order to understand and evaluate the drivers of the demand for new fonio products, a bibliography analysis was done. It was concluded that final buyers of fonio products were the households and the restorers. Surveys were implemented in restaurants (with consumers and restorers) and in markets with current fonio buyers as well.

Several interview guidelines were elaborated in July during the WP1-WP4 workshop in Dakar in order to list the quality characteristics defined by the final buyers of fonio products: restorers, consumers in the restaurants, individual buyers on markets for household consumption.

Surveys were done by ways of semi-structured interviews and focus groups in Bamako-Mali (by Cirad and IER), individual interviews in Dakar –Senegal (by ENDA Graf) and in Conakry and Kindia – Guinea

(by IRAG). For each country, a report is under elaboration. The general synthesis will be completed in April 2007

In Bamako, where most surveys were conducted this year, two types of products are sold in large quantities:
- "traditional" products, i.e. decorticated, sometimes whitened, and sometimes washed.
- "new" products i.e. products decorticated and whitened, washed, precooked and packaged in sealed plastic bags.

Cliché : S. Blancher

Fig. 12: Traditional fonio products near Niger River in Bamako

Cliché J.F. Cruz

Fig 13:Precooked fonio in plastic bag

One survey was implemented in Bamako during September and October 2006 to observe market transactions. 174 purchases of traditional products and 65 new products were observed on the markets and in supermarkets. The contribution of each characteristic to the price elaboration is estimated using a mathematical regression. It shows that the level of processing explains 92% of the price variation. The following characteristics "colour", "size of the grain" and "origin" have a small but significant influence on the price of traditional products. For new products, the place of sale is the only source of variation of price, and the characteristics of the product itself (colours, aspect, and packaging) explain no difference in price.

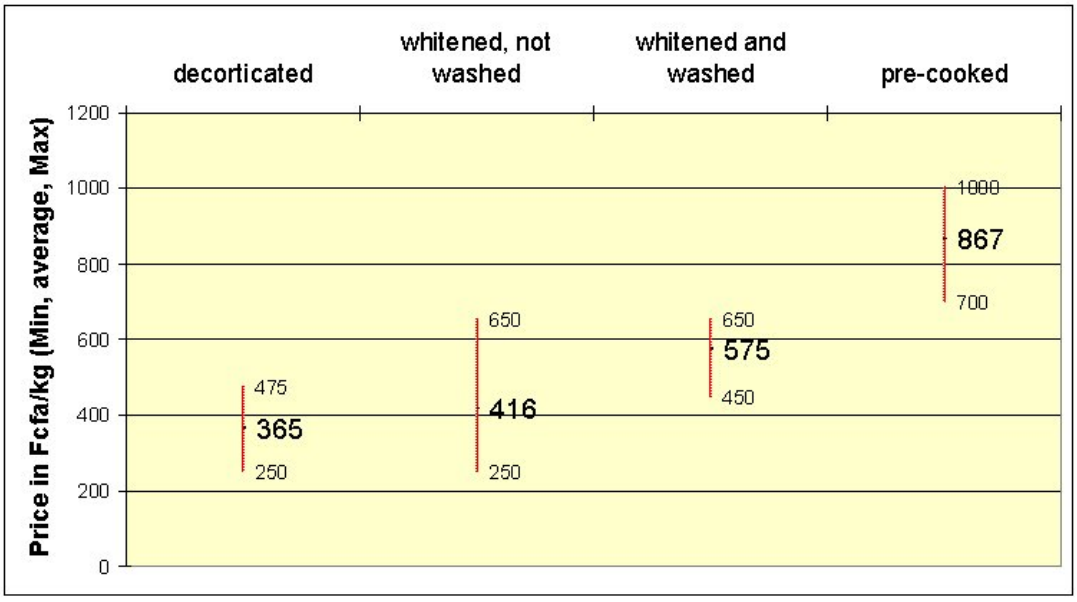


Fig.14: Retail prices of several types of fonio products in Bamako- Mali, October 2006

The method to estimate hedonic prices was used to consider the tacit value that consumer-buyers give to the various characteristics. According to this method, it appears that whitening has a value of CFAF 50/kg, washing a value of CFAF 160/kg, and pre-cooking (+ packaging) a value of CFAF 300/kg. For each characteristic, a hedonic price is estimated. These different values have to be put in perspective because they do not take account of the constraints of the consumers and because they are not the same people who buy the various products. The first results show that the products bought and the paid prices vary according to the type of activity, the sex and the statute in the household of the buyer. The final report will be available in March 2007.

The method to estimate hedonic prices was analyzed and discussed. A new and original method is now proposed. It is the Partial Least Squares (PLS) regression method. This method is avoiding the multicolinearity problems of the traditional method of ordinary least squares (OLS). Cirad currently supplements the bibliography on this subject and compares the methods.

In Guinea and Senegal, the list of the fonio products sold on the markets, their characteristics and their price is still under elaboration.

2.3.2. Evaluation of the demand for fonio products and specific characteristics in European markets (task 3.2)

The main objective of this activity is to identify and to rank consumers' expectations regarding fonio on European markets and to evaluate their willingness to pay for fonio products that may be "gluten free", or "bio" or "fair" or with no specification.

This activity will be implemented in 2007

2.3.3. Impact on income generation and distribution of the development of new products (task 3.3)

The main objective of this activity is to identify the market margins and employment generated by each product ("traditional" and new).

During the period and in order to update the fonio channel data in Mali, in Guinea and in Senegal, it was planned to identify first, restaurants and cheap restaurants (gargotes) which prepares fonio in the main towns and on the other hand, tradesmen and distributors, processors and service providers.

Restaurants and cheap restaurants

An identification list of the restaurants and gargotes was carried out and the typology is under elaboration. With the interview guidelines drew up during the Dakar WP1-WP4 workshop, detailed qualitative surveys were done with some restorers. The results concerning each country are still under analysis

Wholesalers and retailers

An identification list of wholesalers, retailers and SMEs was carried out in order to draw up a typology. With the interview guidelines written during the Dakar WP1-WP4 workshop, detailed qualitative surveys were done with some wholesalers, retailers, salesmen in supermarkets and processors. The data analysis by country is still carried out.

Deviations from the project workprogramme, and corrective actions taken/suggested: identify the nature and the reason for the problem, identify contractors involved

In Guinea, the activities with IRAG were delayed because of problems of communication and lack of computer to analyse data. A joined mission involving Cirad (France) and Enda Graf (Senegal) is planned for the beginning of 2007 to collaborate with the Guinean team on the WP3 and WP4 programs.

List of deliverables, including due date and actual/foreseen submission date

Del N°.	Deliverable name	WP N°.	Date due	Actual/ Forecast delivery date	Estimated indicative person-months *)	Used indicative person-months *)	Lead contractor
17	Report and synthesis for processors on the willingness to pay for different innovations	3	15	23			Cirad
18	Paper about the role of individual and contextual variables in the demand for new fonio products in Africa and in Europe	3	21	24			Cirad
19	Report on the existing prices, costs, market margins and levels of employment	3	30	30			Cirad
20	Report on the impact of new products on income generation	3	30	30			Cirad

List of milestones, including due date and actual/foreseen achievement date

Milestone no.	Milestone name	WP n°.	Date due	Actual/Forecast delivery date	Lead contractor
M3.1.	Processors are identified in each country and involved in the project. They contribute and discuss with food technologist and market specialists what innovation may be possible for local markets	3	12		Cirad
M3.2.	Intermediate workshops (month 6, 18 and 26).	1-4 3&4	6, 18, 27	Done in June 06 Scheduled 17, 27	Cirad
M3.3.	Processors are identified in each country and involved in the project. They contribute and discuss with food technologist and market specialists what innovation may be possible for exports.	3	20	20	Cirad
M3.4.	Information (price, cost, labour) from WP4 and WP5 is available.	3	15	15	Cirad
M3.5.	Final seminar	1-7	35	35	Cirad

2.4. Work package 4 - Small scale enterprises and innovation in product and process

Responsible scientist: Babacar Touré – ENDA Graf (Senegal)
Other participating contractors*:* IER (Mali), IRAG (Guinea) and Cirad (France)

Participant n°	1	4	5	7
Organisation name	Cirad	IER	IRAG	ENDA Graf
Country	France	Mali	Guinea	Senegal
Staff	Mrs S. Dury N. Bricas J.F. Cruz M. Rivier	D. Dramé M. Traoré Mrs B.F. Guindo	Mrs M. Ndiaye	**B. Touré** O. Gueye Mrs F. Ndoye P. Seck

Workpackage objectives and starting point of work at beginning of reporting period

Workpackage objectives

Enda Graf Sahel is involved in the FONIO project as leader of WP4. The overall aim of WP4 is to assess and explain the impact of developing new products and processes on the organization, strategies and economic results of micro- and small-scale enterprises (MSEs). The main three activities under the work package are as follows:

Identification and characterization of MSEs involved in fonio processing
The aim is on the one hand to establish a typology of the MSEs involved in fonio processing and on the other hand to assess the importance of each type of MSE on the market.

Internal management and organization of MSEs. Economic evaluation
The aim is to understand how MSEs are organized and managed, how they manage to be profitable and sustainable, and what products they produce, depending on their history and strategy. Moreover, it is important to be able to identify the constraints on MSEs and their potential for changing their internal management and organization methods so as to improve their products and how they are marketed. Lastly, it is important to compare MSEs producing new products or using new processes and “traditional” MSEs.

MSEs and their relations with suppliers and customers
This means analysing the network of relations. Understanding what strategies and arrangements are adopted between MSEs and the players with whom they are in contact, notably suppliers, distributors, support organizations, the State, funding agencies, service providers, financial institutions, etc. The analysis will identify the constraints and also the potential to modify these relations with a view to increasing production levels, improving quality, diversifying the range of commercial partners, and identifying information circuits, constraints and opportunities for establishing “standards” for fonio processing operations.

State of the art at beginning of the period

Fonio is both one of the oldest cereals in Africa and one of the least promoted, despite its virtues in terms of both nutrition and the potential to generate wealth.

In Guinea, Mali and Senegal, fonio is still a very popular cereal. However, there are differences in terms of both production levels and how it is promoted. While fonio is a staple cereal in Guinea, it is not extensively sold as a processed product, although a start has been made on diversifying the products available, both within the country and in neighbouring countries such as Senegal and Mali, for which Guinea is the main fonio supply basin.

In Senegal, low production (less than 4000 t) and the almost total marginalization of the production chain have not stopped some players from realizing the importance of promoting fonio. Based on the experience of other cereal MSEs (millet and maize) set up in Senegal a few years ago, Senegalese

entrepreneurs were inspired by their Malian colleagues, who had more experience of fonio promotion, processing and marketing. A flagship product—dried, precooked fonio—is now the main product marketed in both Senegal and Mali, although it is less well known and less developed in Guinea.

Several other fonio-based products are sold on the Guinean, Malian and Senegalese markets, involving various degrees of processing and inputs. However, the shift from subsistence crop to commercial product is a relatively recent factor in the sub region. It was primarily linked to the emergence of micro- and small-scale enterprises in Mali, Senegal and Guinea. These fonio MSEs were set up (in Mali and Senegal) with the primary aims of boosting the cereal's added value, generating wealth, and enabling players to become independent by adopting innovations developed by combining traditional know-how and modern knowledge.

Over the years, some considerable expertise has thus been built up in terms of fonio processing and marketing. Niche markets have been discovered and several networks set up. Support organizations are now working with producer networks to boost domestic production, foster product marketing operations and encourage producers to realize the opportunities the fonio market has to offer. Private promoters are now looking to the export market and including fonio in their range of export products. While they specialize in distribution, there are other operators throughout the production chain who also favour the European market (production-processing-marketing for export).

Progress towards objectives – tasks worked on and achievements made with reference to planned objectives, identify contractors involved

The main aim in the first year was to identify and characterize the fonio processing enterprises in the target countries and establish a typology. While MSEs have been identified in Guinea and Senegal, only fonio processing MSEs in Senegal have been characterized and an initial typology produced, for lack of time to process the data on Guinea (obtained in November 2006), while the identification and characterization data on fonio processing and marketing MSEs in Mali are still incomplete.

Cliché : C. Marouzé

Fig 15: Fonio huller in a small enterprise in Bamako (Mali)

Identification and characterization of MSEs involved in fonio processing (task 4.1)

The first censuses in Guinea (Conakry and Kindia) and Senegal (Tambacounda, Kolda and Dakar regions) revealed more than forty MSEs (23 in Guinea and 18 in Senegal) involved in processing and/or marketing fonio products (hulled, unwashed-whitened, dried-washed-whitened, precooked and parboiled fonio, etc).

An initial typology of MSEs in Senegal showed two main types of fonio processing and marketing firms.

Several criteria, including the level of equipment, production level, turnover, infrastructures and product image were used to establish the typology. However, it is important to stress that discrimination criteria are often very tenuous, and it is only by superimposing them that differences appear and categories emerge.

"Micro-enterprises" *or MEs* are primarily characterized by low, irregular production, a lack of designated or appropriate premises, a lack of working hullers, inappropriate packaging (flimsy wrappers), and a turnover of less than CFAF 400 000/year. They are generally community-run (involving producers or producers' organizations and women's groups and organizations), are relatively disorganized and may be in either rural or urban areas.

"Small-scale enterprises" *or SEs* are primarily characterized by much more structured operations, functional equipment (one to three working hullers), a full range of cooking equipment (pots, stoves, basins, calabashes, bowls, spoons, etc), specific premises more or less suitable for production, an annual production or marketed volume of between 1 and 5 tonnes and appropriate packaging facilities (heat-sealed plastic bags with a label describing the product and specifying the manufacturer).

These enterprises are primarily in urban areas, and may be run by communities, individuals or families. They may specialize in processing, distribution and marketing, or just distribution and marketing, in which case they do not process fonio, but buy it in from local or sub-regional processing firms and package it with their own label for sale on the local and export markets. In this case, they are primarily subsidiaries of processing companies.

This first fonio processing and marketing MSE typology for Senegal is to be supplemented and fine-tuned on a sub-regional level, with the results of the planned surveys in Mali and Guinea.

Internal management and organization of MSEs. Economic assessment (task 4.2)

This activity was scheduled for year 2 of the project, but has already begun in Senegal. The first information obtained concerns the range of processed products and characterization of the processes (a film has been produced). Some information has also been obtained on how product quality is perceived, depending on the player, but this needs to be checked and supplemented. An initial insight has been gained into how the firms are run and their various functions, but again, the information needs to be supplemented. The same operations will also have to be done in Guinea and Mali.

MSEs and their relations with suppliers and customers (task 4.3)

The study of links was planned for between the second half of year 2 and the first half of year 3, but proved to be the object of keen interest on the part of the research team during the initial meetings with the managers of MSEs in Senegal. As a result, an initial study has been carried out for Senegal. It identified most of the related players and institutions, but upstream and downstream of the fonio processing and marketing micro-enterprises in Senegal. However, the major part of the work still remains to be done: characterizing the relations of the various MSEs and analysing their impact on the lives of those MSEs, while identifying the opportunities, constraints and risks, in all three countries.

Deviations from the project workprogramme, and corrective actions taken/suggested: identify the nature and the reason for the problem, identify contractors involved

The main difficulty encountered by the ENDA Graf is related to a lack of specific data about the characteristics of MSEs of the fonio commodity channel in Mali and in Guinea. Surveys must still be carried out in Mali and in Guinea. ENDA Graf missions are planned in Guinea (January 2007) and Mali (March 2007) to cooperate with the local teams. However, this delay of data collection should not affect any the validation of the process and the respect of engagements. A better communication between the

WP4 teams in Senegal, Guinea and Mali is now planned to reabsorb the gap so that in June 2007 the report on typology of MPE involved in fonio processing in the three countries is available.

Financial problems towards the end of the period hampered completion of the planned activities, as 15 000 euro were withheld from the initial payment (due to ENDA Graf's NGO status). The situation led Enda Graf to ask CIRAD to bear this shortfall so as not to disrupt the programme of activities.

List of deliverables, including due date and actual/foreseen submission date

Del. no.	Deliverable name	WP n°.	Date due	Actual/ Forecast delivery date	Estimated indicative person-months *)	Used indicative person-months *)	Lead contractor
21	Report on the typology of the SMEs involved in fonio processing	4	9	19			ENDA Graf
22	Report on the internal organisation and economic evaluation of the SMEs	4	24	25			ENDA Graf
23	Report on the supply and marketing systems of the SMEs and its potential and constraints for changes	4	25	30			ENDA Graf

List of milestones, including due date and actual/foreseen achievement date

Milestone no.	Milestone name	Work package no.	Date due	Actual/Forecast delivery date	Lead contractor
M4.1.	A typology of SMEs is available.	4	9	19	ENDA Graf
M4.2.	Intermediate workshops (month 6, 18 and 26)	4	6, 18, 26	Done in June 2006 Scheduled 17,26	ENDA Graf
M4.3.	A characterization of each type of SME is available in term of internal, supply and market organization.	4	24	25	ENDA Graf
M4.4	An assessment of the potential and constraints of each type of SME is available	4	25	30	ENDA Graf
M4.5	Final seminar	4	35	35	Cirad

2.5. Work package 5 - Opportunities for diversification and multipurpose uses of fonio in crop-livestock farming systems

Responsible scientist: M. Eric Vall – CIRDES (Burkina Faso)
Other participating contractors*:* IRAG (Guinea), IER (Mali), Cirad (France) and CRAW (Belgium)

Tasks	5.1. Analysis of diversity	5.2 Characterization of role of fonio in cropping systems	5.3 Analysis of production and prospective strategies	5.4 Characterization of socio-technical environment	5.5 Design of innovations
Year	2006	2007-2008	2007	2007	2007- 2008
CIRDES	Eric VALL Augustin B KANWE Bakary DAHO	Eric VALL Augustin B KANWE Bakary DAHO	Eric VALL Augustin B KANWE Bakary DAHO	Eric VALL Augustin B KANWE Bakary DAHO	Eric VALL Augustin B KANWE Bakary DAHO
IRAG	Famoï BEAVOGUI Tierno Alimo DIALLO Mah Aïcha Kollet SOUMAH	Famoï BEAVOGUI Tierno Alimo DIALLO	Famoï BEAVOGUI Tierno Alimo DIALLO	Famoï BEAVOGUI Tierno Alimo DIALLO	Famoï BEAVOGUI Tierno Alimo DIALLO
IER	Diakalia SOGODOGO Moctar TRAORE	Diakalia SOGODOGO Moctar TRAORE	Diakalia SOGODOGO Moctar TRAORE	Diakalia SOGODOGO Moctar TRAORE	Diakalia SOGODOGO Moctar TRAORE
Cirad	Patrick DUGUE	Didier RICHARD Patrick DUGUE			Patrick DUGUE Didier RICHARD
CRA-W	Brice DUPUIS	Brice DUPUIS	x	x	Brice DUPUIS

Table 8. Partners' involvement and names of WP5 correspondents per organization, per activity and per year

Workpackage objectives and starting point of work at beginning of reporting period

WP5 is intended to generate knowledge of the range of production systems in which fonio is grown. For each type of system identified, the aim is to determine fonio's position within the range of crop (and animal) products, the cropping methods used (cropping plans, rotation, crop management sequences; links with WP6), its role in generating household income, and its different uses (food, fodder, cover crop, etc.). Producers' aims and strategies are to be characterized so as to clarify the changes observed (diversification, and also specialization, export and sometimes abandoning) and to establish links with market determinants (WP3). The sociotechnical environment in which fonio is produced is also to be studied (producers', traders' and various private service providers' organizations), to pinpoint areas in which the demand for services is not covered and that may hamper the expansion of the crop (technical advice, seed supplies, agricultural machinery, etc).

Based on this wide-ranging diagnosis, the possibilities of agronomic and organizational improvements will be identified and a start will be made on designing innovations hand-in-hand with producers. After working with those producers to define the constraints on production, the next step will be on-farm tests of fonio varieties (ecotypes, cultivars; see WP6) whose agronomic characteristics tally with the producers' objectives, notably in terms of versatility (grain, straw, by-products and also improved soil fertility). Cropping techniques—particularly intercropping and the introduction of no-till cropping methods—and the means of using fonio straw will be tested and adapted under farm conditions (in relation with WP6). Support could also be given to the emergence of "fonio" professional organizations, in relation with WPs 3 and 4, notably to improve quality and competitiveness.

Specific objectives

1 Analysis of the diversity of fonio based farming systems.
2 Characterization of the place of fonio inside the crop-livestock systems and the recent evolutions.
3 Analysis of the actual strategies and the prospective.
4 Characterization of the assets and constraints of the socio-technical and organisational environment.
5 Elaboration of schemes for the co conception of innovation processes.

Progress towards objectives – tasks worked on and achievements made with reference to planned objectives, identify contractors involved

The year 2006 was devoted to the first objective

2.5.1. Analysis of the diversity of fonio producers (task 5.1.)

Objective and methodology

During this first year, the main objective of WP5 was to analyse the range of fonio producers in Burkina Faso, Guinea and Mali and characterize the importance of fonio in production systems and the crop management sequences used for fonio.

To this end, a survey entitled "Analysis of the range of producers and importance of fonio in the production system" was conducted under WP5 in the main fonio production basins of Guinea, Burkina Faso and Mali, involving 300 producers (100/country)

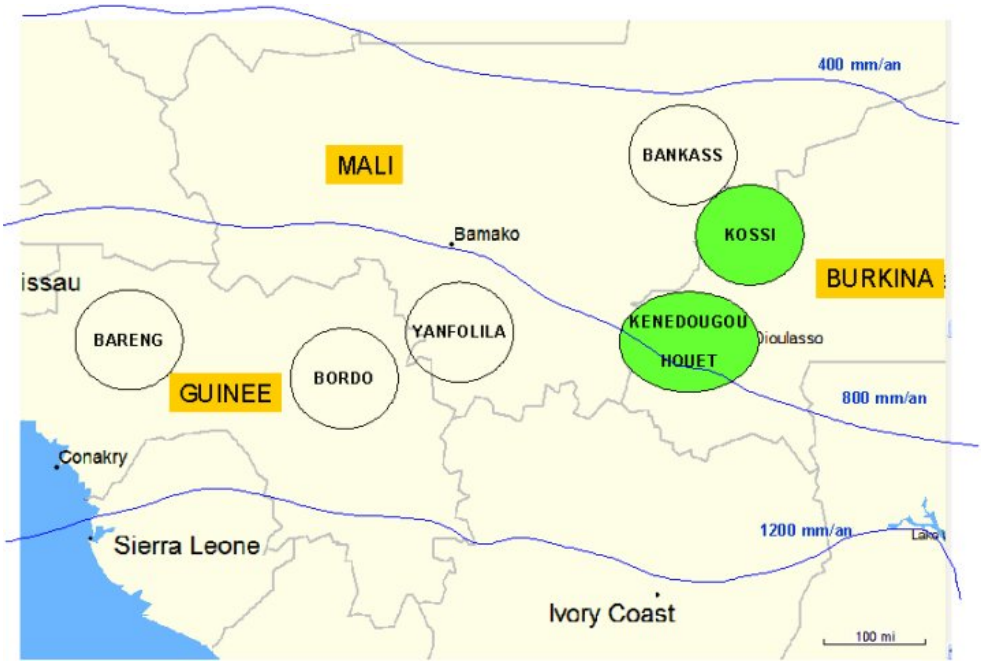


Fig. 16: Main fonio production basins in Guinea, Mali and Burkina Faso (circles)

The results of the survey are still being analysed, but it should give rise to:

1) a fonio producer typology for each country
2) a characterization of the importance of fonio in production systems (importance in cropping plan, household cereal consumption, local culture, etc)
3) a characterization of the fonio crop management sequence (selection of varieties, soil preparation, sowing, upkeep, post harvest methods, storage).

The calendar for survey 5.1 was as follows:

- Drawing up of the questionnaire: April 2006
- Identification of producers in villages: May-July 2006
- Start of survey: end of July 2006 (after weeding, etc)
- End of data gathering: end of September 2006 (before harvest)
- Data analysis and production of reports (October 2006- February 2007).

Results

For the moment, only the survey data from Burkina Faso had been analysed and were available, hence they are the only results presented below.

In Burkina Faso, the agroecological situation of the two survey zones, the main fonio production basins in Burkina Faso, has a significant influence on their agropastoral characteristics:

- Kossi (semi-arid zone in the North) is a zone where rainfall is a limiting factor (700 mm/year on average) and sandy soils are dominant. Its agriculture is dominated by traditional cereals (sorghum, little millet and fonio), primarily grown for food purposes. Sesame and to a lesser extent cotton are the main two commercial crops. The whole zone produces fonio, but the production epicentre lies between Djibasso, Barani and Doumbala. Animal production (cattle and small ruminants) is more significant in the South, to provide draught animals and savings, and to cover small emergency expenditure.
- Kenedougou-Houet (subhumid zone in the South) is a zone where rainfall is not a limiting factor (> 1000 mm/year), but the soils are relatively poor. Its agriculture is very diversified, but dominated by arboriculture (mango, cashew and citrus species), cereals (maize, sorghum, millet and fonio), legume crops (groundnut and cowpea) and roots and tubers (yam and cassava). The main commercial crops are the products of arboriculture and to a lesser extent legume crops (cowpea and groundnut). Animal production is not significant (mainly for animal draught).

The farm typology is based on three criteria

- The importance of fonio in the cropping plan (% of the cropping plan area planted with fonio);
- Whether fonio production is geared towards sales (volume of fonio sold/household/year);
- The role of women in cropping operations (% of area under fonio managed by women/production unit).

Production basins	**North (Kossi)**		**South (Kenedougou-Houet)**			
Type	**Djibasso**	**Nouna**	**Orodara**	**Toussiana**	**Producing woman**	**Average**
Fonio area/cultivated area	**27 %**	8 %	**24 %**	**26 %**	**28 %**	17 %
Fonio sold/PU/year (kg)	**712**	97	97	**303**	**337**	222
Fonio area managed by woman/PU	0 %	2 %	0 %	1 %	**58 %**	6 %
General characteristics	Important fonio area + Important sales	Fonio less important than other types	Important fonio area	Important fonio area + marketing	Important fonio area + marketing	

Table 9. Typology of farms producing fonio

The resulting typology distinguishes between five types:

- Two in the North, which differ in terms of the importance of fonio in the cropping plan and whether it is grown for sale; around Djibasso, there is a marked tendency to produce and sell fonio, while around Nouna, fonio only serves as a stopgap crop, and the cropping plan is dominated by sesame and cotton grown for subsequent sale;
- Three in the South: one type in which women are heavily involved in growing fonio, one with a marked tendency to grow fonio for commercial purposes and another less commercially-oriented type (Orodara).

The main structural characteristics of the five types of production unit are shown in table 10. The units are extended family farms, growing around 10 ha/year. Animal production is primarily practised in the semi-arid zone (Djibasso, Nouna)

Type	Djibasso	Nouna	Orodara	Toussiana	Producing woman	Average
Mouths to feed	16,6	15,3	13,4	16,3	19,7	15,3
Workers	9,2	8,4	7,6	8,1	10,8	8,4
Cultivated area (ha)	8,4	13,7	8,6	10,4	9,7	10,9
UBT Unité de bétail tropical (250 kg)	11,2	16,7	4,1	9,5	4,5	10,7

Table 10: General characteristics of production unit types

The importance of fonio on these farms is relatively consistent (around 25% of the area planted, i.e. an average of 2 ha/PU), with the exception of the Nouna zone where the figure is 8%.

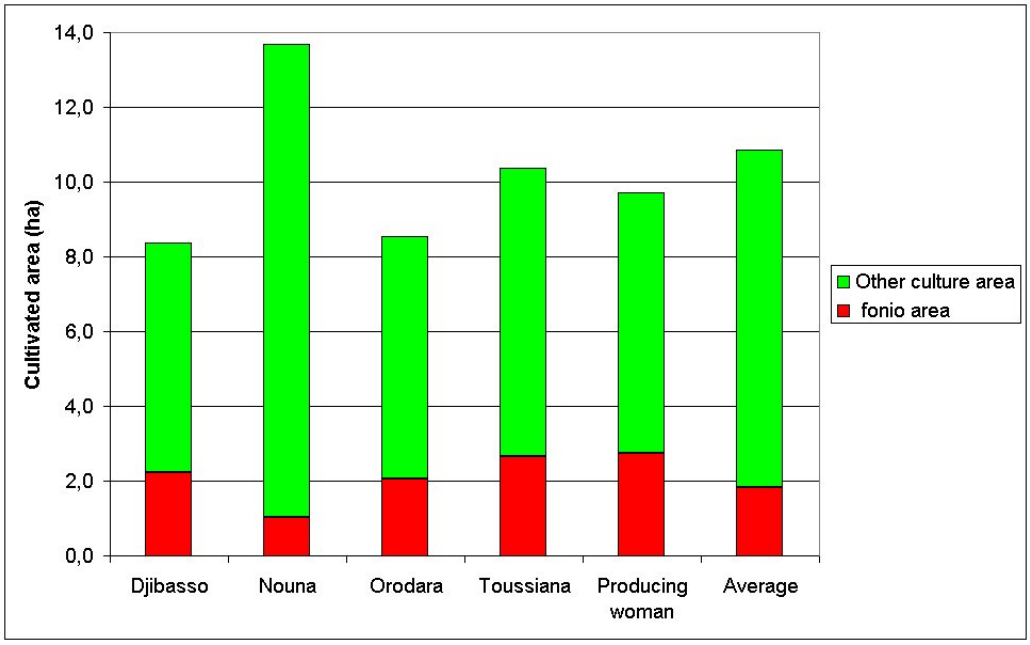


Fig. 17: Proportion of fonio (in ha) in the area cultivated

The importance of fonio in household food consumption differs substantially between the North (Kossi:, fonio is the main stopgap crop between September and November) and South (Kenedougou/Houet). In the North (Kossi), household consumption peaks between September and November and is virtually nil thereafter (Figure 18).

As fonio is the first cereal to ripen in September, it is the main food cereal at that time of year, before being replaced by sorghum and millet, which ripen in October and November. Fonio acts as a stopgap crop when grain lofts are empty. In the South, fonio is eaten consistently throughout the year. It fits into a broader range of food crops (cereals, legumes and tubers). Fonio is cooked to make Tô (balls in which it is often mixed with maize), semolina (couscous), gruel or fritters.

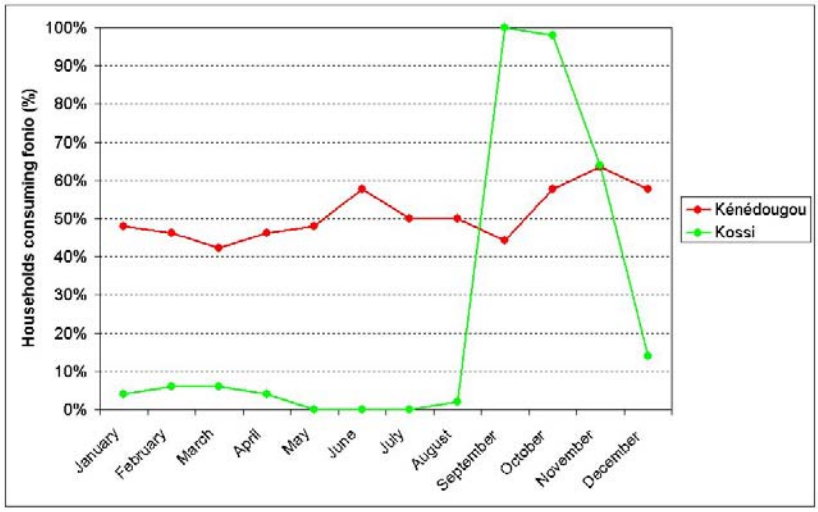


Fig. 18: Monthly household fonio consumption depending on the production basin

Fonio sales rates also differ significantly depending on the agroecological zone (Figure 19). In the South (Kenedougou), producing households sell fonio on markets quite regularly throughout the year (around 20% of households sell small amounts of fonio all year round to satisfy their day-to-day cash requirements). As with household consumption, in this case fonio fits into a broad range of crops sold on markets (cashew, mango, citrus species, cowpea, groundnut, etc). In the North (Kossi), there are two sales peaks. Between September and November (first peak), 60 to 90% of households sell fonio on local markets. This peak is due to the strong local demand for cereals at that time of year, which drops off as soon as the sorghum and millet crops ripen (October, November). The second peak is between April and July, when agricultural foodstuff prices as a whole rocket on local markets and farmers sell any remaining fonio in their grain lofts. In the case of women growing fonio (*"productrices"*), sales peak between May and June, which apparently proves that their commercial strategy is to concentrate sales in periods of high cereal prices (long stopgap period). As an example, in the Kenedougou-Houet region where these women are based, the price per kilo of paddy fonio leapt from CFAF 300/kg after the 2005 harvest to CFAF 700/kg in June 2006, which amply demonstrates the merits of selling it in May and June.

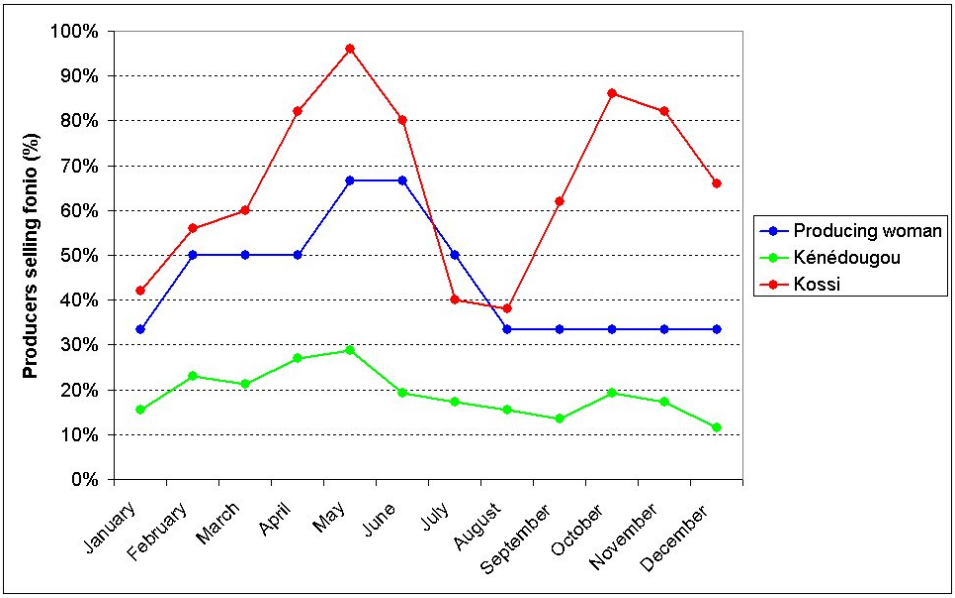


Fig. 19: Proportion of households selling fonio each month, depending on the production basin and in the case of women growers

According to producers, fonio seems to play a more important role in the culture and in producer habits in the Kenedougou-Houet production basin (weddings, celebrations, funerals, burials and initiation rites).
Fonio producers generally distinguish between three types of variety: early, intermediate and late (Each variety has a common name and is defined by a certain number of characterization variables such as cycle length, grain colour and panicle characteristics (number of racemes). Producers in the North prefer early varieties due to the area's low rainfall (which means that sowing is late and food is required as of the end of September). Producers in the South favour later varieties (sowing is earlier and there is less need for stopgap crops in September). The survey data revealed that later varieties are more productive, but require larger quantities of seed and more upkeep (weeding). Yields are higher in the South than in the North (683 kg/ha compared to 589).

NB: The survey data on the characteristics of local fonio varieties will have to be supplemented with trials in a controlled environment for botanical characterization (morphology) and agronomic characterization (sensitivity to photoperiodism, cycle length, yield, etc).

Cycle length	Varieties local names	Sowing date	Reaping date	Seed rate (Kg/ha)	Weeding duration (days/ha)	Yield (kg/ha)
Early (108 days)	Pémouso, Péfoso, Funigbé, Pébio, Wanwoulé, Foniba	1 June	19 Sept	29	9	578
Intermediate (128 days)	Ténaïlé, Fungban, Waré	9 May	15 Sept.	40	20	673
Late (148 days)	Woussangué, Funlo, Wonotono, Wouaké	3 May	28 Sept.	36	25	704
Average (124 days)		19 May	20 Sept	34	18	635

Table11. Characteristics of fonio varieties in Burkina Faso

The crop management sequence for fonio and the variants per type of production unit are shown in table 12 and figure 20. Fonio producers grow one or sometimes two fields of fonio on an area of 2 ha on average. The fonio plots are generally quite old, particularly in zones where the extent of agricultural activity rules out practising fallow (Djibasso). They are primarily planted on generally sandy plain and hill soils. Most fonio plots nowadays are ploughed, but some (often elderly) producers still prepare their fields with a daba (hoe). Fonio is then broadcast-sown on the freshly ploughed soil and covered over using branches as brooms. More seed is used in ploughed plots than in plots prepared by hand, due to the irregularity of the seed bed in ploughed fields, which increases the risk of the fonio seeds being buried (36 and 28 kg/ha respectively). The fields are hand-weeded once and are not given any inputs. Striga seems to be the main enemy for fonio. The crop is cut between mid-September and mid-October, and the operation is highly labour-intensive (30 man-days/ha). Harvesting is generally done by men, with groups of farmers helping each other. The fonio sheaves are then left to dry in the field for a week and threshed on site.

Type	**Djibasso**	**Nouna**	**Orodara**	**Toussiana**	**Producing woman**	**Average**
Nb of fonio plots	1,3	1,1	1,1	1,8	1,7	1,3
Field age (years)	**34**	11	7	10	11	13
tillage (Animal Traction)	71%	95%	57%	65%	57%	69%
Sowing date	7/6	30/5	11/5	25/4	9/5	19/5
Seed rate kg/ha	28	30	33	**52**	25	34
Nb of weeding	**0,8**	**0,6**	1,2	1,1	1,1	0,9
NPK, Urea, manure	0	0	0	ε	0	2
Reaping date	18/9	17/9	23/9	15/9	8/10	20/9
Sowing-reaping gap (days)	103	110	135	143	152	124
Fonio production kg/PU	1523	595	1332	**2143**	**2375**	1245
Fonio yield (kg/ha)	617	586	633	812	613	637

Table 12. Fonio crop management sequence in Burkina Faso

Threshing is generally done with a stick, but sometimes still by treading (the traditional way). This is also highly labour-intensive, again involving self-help groups (30 man-days/ha). The fonio is subsequently stored in grain granaries or bags. Paddy fonio stores well for several years in a grain granary.

Hoe (daba) for manual tillage

Plough tillage

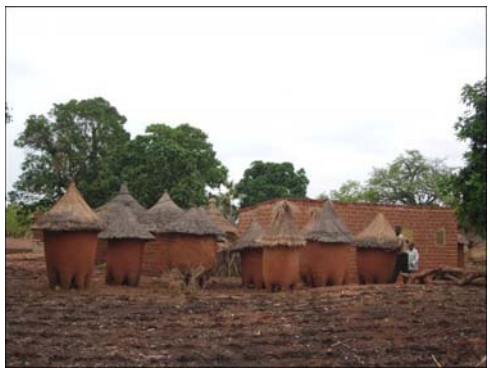
Seeds of fonio

Fields of fonio sown

Fonio reaping

Threshing with sticks

Threshing by treading



Fonio granaries in Kénédougou

Fonio granaries in Kossi province

Clichés : E. Vall

Fig. 20: Illustrations of the fonio crop management sequence in Burkina Faso

Fonio production requires some financial expenditure, generally around CFAF 15 000/ha , well below the figure for cotton. The main costs are labour for reaping and threshing, and draught animal hire. Expenditure is significantly higher in the South (Toussiana, Orodara, producing women) than in the North (Djibasso, Nouna), since producers in the South use more outside labour for their many crops, whereas production is primarily family-based in the North.

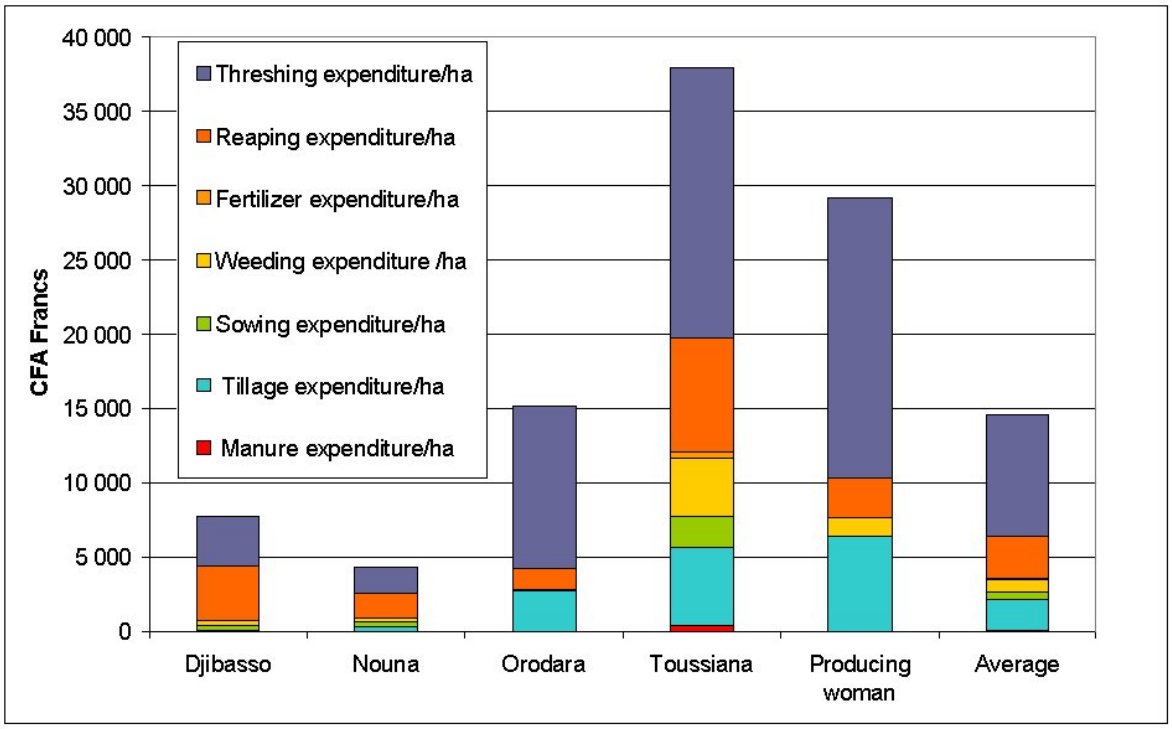


Fig. 21: Distribution of expenditure per item (in CFAF/ha of fonio)

Deviations from the project workprogramme, and corrective actions taken/suggested: identify the nature and the reason for the problem, identify contractors involved

The main problem encountered has concerned the implementation of the survey “Analysis of the range of producers and importance of fonio in the production system”. In November 2006, the three research teams were on very different levels of advance.

In Burkina: data collected, database seized, data analyses realized
In Guinea: data collected, database in course of seizure:
In Mali: data collected

This fact explains why the delivery date of the deliverable n°24 was delayed and now scheduled for March 2007

Another problem relates to the development of a regional database on the farming systems integrating the fonio. Most researchers do not master the use of the database software. The solution will be to organize a training course with an external expert during a 10 days workshop in Cirdes (Burkina). But the financing of this training course has to be found.

List of deliverables, including due date and actual/foreseen submission date

Del N°.	Deliverable name	WP N°.	Date due	Actual/ Forecast delivery date	Estimated indicative person-months *)	Used indicative person-months *)	Lead contractor
24	Report on production systems typologies, databases, identification of priority zones for intervention	5	12	15	15	12	CIRDES
25	Report - Place of fonio in the whole farming system, priorities to strengthen the place of fonio in the household economy	5	21	27	12	0	CIRDES
26	Farmer's strategies and condition to improve the use of fonio as a diversification process	5	21	27	3	0	CIRDES
27	Report - Assessment of the socio-technical environment of the farmers producing fonio : conditions for supporting the emergence of professional organization « fonio » and improving the services	5	25	27	3	0	CIRDES
28	Activities plan : options for the development of fonio production and the improvement of the productivity and competitiveness	5	26	28	3	0	CIRDES
29	Dissemination of knowledge obtained into the project: publication of technical information, intervillages visits, papers for newspapers and audiovisual presentations	5	33	36	12	0	CIRDES
30	Scientific articles and communications in international conferences	5	35	35	3	0	CIRDES

List of milestones, including due date and actual/foreseen achievement date

Milestone no.	Milestone name	WP n°.	Date due	Actual/Forecast delivery date	Lead contractor
M5.1.	Start up Workshop: planning, general methodology and WP5 workplan (m1 –m4).	7-5	1	Done in March 06	Cirad and CIRDES
M5.2.	Typologies and report: data collection (4mths) , database building multivariate analyses (3 months) workshop (month 13).	5-6	12 13	Scheduled 17 Done in Nov 06	CIRDES
M5.3.	Parallel cases studies (place of fonio, farmer's strategies socio-tech and organisational environment) (months 3-23)	5	23	Scheduled 27	CIRDES
M5.4.	Consolidation of the diagnostic phase results - Workshop – (month 25)	5	25	Scheduled 22	CIRDES
M5.5.	Co-conception of innovation: evaluation of the processes in narrow partnership with the farmer's organisation and the other stakeholder in the socio-technical environment.	5	25	Scheduled 33	CIRDES
M5.6.	Final seminar month 35	7	35	35	Cirad and IER

2.6. Work package 6 - Improving knowledge on fonio based cropping systems and ways for improving productivity.

Responsible scientist: M. Didier Stilmant – CRAW (Belgium)
Staff of the CRAW (Farming systems section) from Belgium is leading the Work Package 6 in close cooperation with Cirad (France).

Other participating contractors*:* IRAG (Guinea), IER (Mali), CIRDES (Burkina) and Cirad (France)

The different scientists involved are the followings

Participant n°	1	3	4	5	6
Organisation name	Cirad	CRA-W	IER	IRAG	CIRDES
Country	France	Belgium	Mali	Guinea	Burkina
Staff	**F. Forest** J. Chantereau	B. Dupuis **D. Stilmant**	M.D. Sanogo D. Guindo M. Vaksmann	T.A. Diallo N'F. Cissé A. Baldé A. Sané. G. Niéba J. Gigou	E. Vall B.A. Kanwe

Table13 . Partners' involvement and names of WP6 correspondents per organisation

Workpackage objectives and starting point of work at beginning of reporting period

The general aim of work-package n°6 is to improve the existing knowledge on fonio based cropping systems and ways for improving their productivity with attractive socio economical and environmental benefits and in phases with the market chain expectations. This had led to the definition of the following specific objectives:

1- Better knowledge on fonio varieties (morphologic diversity, genetic functioning, photoperiodism, cycle duration…) and capacity building for seed production and conservation meeting the needs of the different WP of the project and its follow up.

2 - Climate- soil- nutrients -biomass potential and efficiency analysis: Potential production of biomass for collected varieties depending on climate and nutrients resources. In situ flux study, water and nutrients balance for representative ecosystems.

3 - Present Fonio based Cropping System diagnosis: rapid survey of existing cropping systems and practices and analysis of actual biophysical performances under farmers conditions (link with WP5). Comparison of actual productivity with potential.

4 - Close the gap through innovation: To identify with farmers the desirable experiments aiming at increasing the resiliency of the cropping system (water nutrient efficiency, higher productivity, externality control)

There is a large scale of documentations concerning soudano-sahelians farming systems. The reason is that those systems are fragile and submitted to important soil and water resources constraints. Unfortunately, few of those publications focus on the place of fonio crop within these systems. Indeed, fonio has been for a long time considered as a minor cereal in comparison with sorghum, millet, rice and maize. For that reason, bibliographic resources concerning fonio are very poor.

The first articles were registered in the beginning of the XX century. They developed characterization of fonio botanical features: the first classification was proposed by Roland Porteres in 1955. This publication also developed farming systems description. This article and an additional publication of 1976, from the same author, are still considered as references by the scientists.

Indeed, till the nineties, no deep and developed researches were done concerning this culture. Since 1995, agronomical probes and sociological survey were initiated in Guinea. Few general publications concerning fonio were also proposed around the second part of the nineties. Those publications represent the birth of a new international interest for this culture. Approaching the XXI century, large scale initiatives were built up to promote fonio. First of all, the IPGRI workshop concerning fonio genetic diversity has to be highlighted. This workshop took place in Conakry in 1998. This event gathered most of the west-Africans fonio researchers. The topics of the discussions were quite large and were developed in an exhaustive report. One year later, the CFC project, led by Cirad, proposed an original study of post-harvest technologies of fonio. The principal objective of this project was to improve the efficacy of actual post-harvest technologies. However, interesting agronomic probes were managed in Mali, Burkina-Faso and Guinea. To resume the bibliographic situation of fonio, developed in the deliverable 3.2. (the finalised and definitive version will be available in March 2007), we can say that a lot of domains remain to be explored. In such a context, the present project will contribute to enlarge the knowledge about fonio.

Cliché J.F. Cruz

Fig. 22: Field of fonio in Fouta Djalon (Guinea)

Progress towards objectives – tasks worked on and achievements made with reference to planned objectives, identify contractors involved

Major achievements of the WP6, in respect to the specific objectives, during the year 2006, are:

- The definition of a clear work program for the all project lasting;
- The collect and the characterisation of the production potential of a set of varieties in Guinea and in Mali;
- The definition of fonio response to abiotic factors (fertilisers, photoperiodism, …) in term of biomass production and distribution;
- The collect of agro-meteorological data;
- The identification of the zones and the performing, by the WP 5, of the diagnosis of local agroecological knowledge on fonio cultivation coupled to the identification of the main factors (varietal, agronomic, socio-economic…) that refrain development of fonio production;
- The production and the distribution of the raw material necessary to WP1 and WP2 for technological and nutritional analyses.

2.6.1. Varietal characterisation (Task 6.1)

During this first year, an inventory of the main knowledge on fonio (*Digitaria exilis*) variety diversity and cropping systems was done with a special interest for the approaches performed in West Africa. This state of the art will be reported in the deliverable 3.2.).
In parallel and on the basis of the local experts knowledge, three main area of production, corresponding to three eco-regional zonation taking account for rain, soil and altitude constraints, where identified from Guinea to Burkina Faso. Within each of these areas one experimental station, for IRAG or from IER, is able to perform fonio varieties comparisons:

- Bareng (IRAG), in the Fouta Jalon (Guinea) is characterized by a high level of rains, contrasted topo-sequencies and soil with a high level of acidity. This minor cereal covers till 60 % of the useful agricultural surface (UAS).
- Bordo (IRAG), in High Guinea, with a lower level of rain and with a less uneven landscape. The fonio takes a less important place in these farming systems.
- Cinzana (IER), near Ségou (Mali), in the North of the cotton area, with the lowest level of rain (less than 700 mm per year) and the more 'intensive' cropping systems as no place remains for fallow fields.

A deeper description of these experimental sites will be delivered in February 2007 (Deliverable D31).

2.6.1.1 Farmer characterisation of the most popular fonio varieties according to usual farmer management and ecoregional zonation taking account for rain, soil and altitude constraints in Guinea and Mali.

This task was performed in collaboration with the WP5. During the start up workshop, an ecoregional zonation taking account for rain, soil and altitude constraints in Guinea, Mali and Burkina was set up through experts' knowledge. Representative villages of six contrasted zones were identified to perform the surveys and typology of the exploitations producing fonio and to collect the more representative varieties cultivated across these different zones. These varieties are now under characterisation through the definition of their technological use value, by the WP1, and through the definition of their biochemical and botanical parameters, by the WP6.

The first survey, at the farm scale, is now finished and the WP5 will focus on the establishment of a global data base on farms and fonio systems description, data base that will be available for the different WP of the consortium

2.6.1.2 Collect of these most popular fonio varieties in Guinea and Mali and comparison in on-station and multilocal experiments (in Guinea and Mali) for agro morphological characteristics, yield (grain and fodder) and farmers evaluation.

During this first year the Guinean teams have collected 12 popular fonio varieties in Guinea while Malian team has compared the 5 best performing varieties identified in the CFC/IGG – (FIGG/02) project after a re-adjustment of the sowing rate for the poor germination potential of the old seeds they have used. The results are under analysis.

One of the main output of this first season is the standardisation of the protocols and of the measured parameters (review of protocols will be delivered in February 2007 with the Deliverable D34) with their re-adjustment following the post rainy season workshop, with fields visit, set up to identify the problems encountered during the experimental work.

2.6.1.3 Providing grain and fodder samples to WP1 and WP2 for technological and nutritional analyses and to WP6 for on field experiments :

Running task.

2.6.2. Climate soil resources assessment in relation with fonio potential in Guinea and Mali (Task 6.2.)

2.6.2.1 As fonio biomass productivity seems to be highly climate dependant, a multilocal survey is carried out combining field experiments for quantifying the potential of production (total dry matter and yield components) of fonio varieties and ecotypes pre selected (see WP1) and confirmed for their a priori interest through a rapid survey and interviews with producers.

During this first year, field experiments were set up in Sotuba (IER-Mali) and Bordo (IRAG-Guinée) to meet this objective. They aim to quantify the photo-periodic response of the varieties compared from their production potential point of view (see 2.6.1.2.) in order to define their adaptability/plasticity face to environmental variations and their sensitivity to the sowing date (cycle length). An experiment was also set up in Sotuba to characterise the allometry of the production: distribution of the biomass in root/ stemm / leaf organs. Protocols will be described in Deliverable D34. The results are under analysis.

In 2007, these approaches will focus on the varieties collected in Burkina Faso by the WP5 and characterised, by the producers, from their cycle length point of view, in order to validate this producer knowledge against experimental observations.

Cliché M. Vaksmann

Fig. 23: Experimental plots in IER Sotuba station in Mali

2.6.2.2 Responses to water and fertilisers are analyzed on field plots (Bareng, Bordo, Sotuba) and yield indexes (dry matter, grain, fodder..) are discussed in relation with climate and soil water balance parameters and ecotype characteristics (WP1).

To characterise these responses two preliminary experimental designs where set up in 2006.
The first aims to identify the nutrients of interest (N, P, K, Ca, …) to be included in a deeper 'fonio nutrient response' investigation. It was set up in the two Guinean experimental sites, in two repetitions, one with and one without basic fertilisation.
The second aims to characterise the heterogeneity, in term of yield potential and so of nutrients distribution, of the fields designed to support the fertilizers response studies in 2007. This was done in three sites ; the two experimental sites from Guinea and the site of Cinzana (Mali).
Protocols will be described in Deliverable D34. The results are under analysis.

In 2007, Fonio response to NPK (3 levels for each nutrient, in a complete factorial design) will be analysed in the three characterised fields. This in a three blocs design, each bloc will be implanted in an area with an iso-potential in term of yield.

Cliché J.F. Cruz

Fig.24: Harvest in experimental plot (IRAG).

Cliché J.F. Cruz

Fig. 25: FONIO Project staff visiting IRAG Bareng Centre

2.6.2.3. A fonio oriented agroclimate data base is initiated (rainfall data for years 2005 to 2007 and for the last 20 years for almost 20 rainfall stations).

These agro-climatic data are collected in or close to the different experimental stations. Rainfall will also be collected in the villages that will be followed up in 2007 (§ 2.6.3.2.). Historical data will also be compiled for the last 20 years.

2.6.3. Diagnosis of local agroecological knowledge on fonio cultivation and identification of the main factors (varietal, agronomic, socio-eco.) that refrain development of fonio production (Task 6.3.)

2.6.3.1. Implementation of rapid appraisal surveys through open interviews and semi structured questionnaires (with WP5).
This was performed in collaboration with the WP5 as described in the point 2.6.1.1.

2.6.3.2. Field observations and rapid inventory of systems components and climate environment.
This will take part to the task 5.2. of WP5 in 2007 'Characterise the place of fonio inside the crop-livestock systems and the recent evolutions'. This task will analyse the crop rotations and technical itineraries associated to fonio across a subset of 60 farms (20 per country, in link to the typology to be performed during this winter: 2 villages per country). Early and late varieties will be followed up with yield and climatic parameters recording, grain and straw quality characterisation. For most information see the WP5 report.

2.6.3.3. Gap (potential to reality) analysis (with WP5).
This action will start in 2007, through the implementation of most promising varieties identified in some villages or in experimental station in some villages with lower performances this to stimulate producers interactions on possible fonio variety innovation.

2.6.4. Closing the gap through innovation and sharing knowledge (Task 6.4)

2. 6.4.1. Annual participatory assessment of results implemented with all stakeholders (all WPs).
To be organised, in 2007, with all the WPs.

2.6.4.2. Scientific discussion, validation of results and issues for the future (zero tillage, mulch based cropping systems..) : For 2008.

2.6.4.3. Designing of adoptable site specific measures for enhancing fonio performances : For 2008.

Deviations from the project workprogramme, and corrective actions taken/suggested: identify the nature and the reason for the problem, identify contractors involved

Due to a poor germination potential of the conserved seeds for the main varieties identified in the previous (CFC/FIGG/02) project, the Guinean teams have collected 12 popular fonio varieties in Guinea while Malian team has used the old seeds with an adjustment of the sowing rate for the poor germination potential. This leads to some difficulties in terms of results comparison for 2006.

After this regeneration year, it was decided to test, in 2007, 13 out of the best varieties identified in 2006. These varieties will be distributed as follow, on the basis of their geographical origin and of their level of precocity.

Cycle length if sown early in June	Early (90 days)	Intermediate (120 days)	Late (150 days)
Origin			
Guinea	*2*	*3*	*3*
Mali	*3*		*1*
Burkina Faso	*1*		

Table 14: Origin and type of the varieties that will be tested in 2007

List of deliverables, including due date and actual/foreseen submission date

Del. no.	Deliverable name	WP N°	Due date	Actual/ Forecast delivery date	Estimated indicative person-months	Used indicative person-months *)	Lead contractor
31	Definitive choice of preliminary study sites in each country	6	3	14			CRAW
32	Blue print providing a comparative state of art on existing knowledge on varieties and fonio based cropping systems	6	12	15			CRAW
33	Concerted approach and methodological steps for combining biophysical and socio-economic multiscale data	6	3	14			CRAW
34	List and conceiving of desirable on field experiments dealing with the characterization of varieties and improvement of biophysical environmental performances of the cropping system	6	3	14			CRAW
35	List and conceiving of the farmer's reference associated network. (PRAs…)	6	3	17			CRAW
36	Implementation (2 years) of agronomical experiments, 4 seasonal reports	6	33	33			CRAW
37	Analysis of results, synthesis and scientific articles production		30	30			
38	Varietal catalogue of the most popular fonio varieties	6	12	24			CRAW
39	Guidelines for the empowerment of local communities in participative actions for diffusion of innovations	6	30	30			CRAW
40	Communication, edition of main results in national regional international meetings	6	35	35			CRAW

Justification of putting off deliverable deliverance:

Deliverable 31: The in-farm experiments could not be initiated in 2006 because of the necessary time to build the farmers network. Consequently, the study sites choice hasn't be achieved in 2006 and the deliverable 31 has been postponed to February 2007.

Deliverable 32: We will finish the centralization of last scientific articles at the end of 2006, the synthesis will be finalised in March 2007.

Deliverable 33: This methodology has been build during the two WP6 workshops. Numerous discussions permit to construct a clear synthesis of the partner's opinions and inputs. So this deliverable will be furnished in February 2007

Deliverable 34: Trials protocols redaction has been ended in June 2006, just before field trials. One of those protocols has been adjusted during 2006 trials. So, the complete protocols inventory will be available in February 2007.

Deliverable 35: During the first workshop of the project, in March in Bamako, the partners decided to work in to step in order to build a farmer's reference network. The first step, performed in 2006, lay in the characterisation of the main basins of fonio production across the three countries. To do so a typology of the production systems diversity was performed. The farmer's reference network will then be implemented to be representative of this diversity. So this deliverable will be available in May 2007.

Deliverable 38: A large collect of cultivars has been decided during the annual reunion of Montpellier in December 2006. This sampling will be executed by the WP5 in 2007. In order to integrate these cultivars into the variety catalogue, we will furnish it at the end of 2007.

List of milestones, including due date and actual/foreseen achievement date

Milestone N°	Milestone name	WP n°	Date due	Actual/Forecast delivery date	Lead contractor
M 6.1	Start up workshop to define the organisation of the work within the teams and methodology for task 6.1and 6.2.	6	1	Done in March 06	CRAW & Cirad
M 6.2.	Intermediate meeting to prepare the methodology of tasks 6.3 and 6.4.	6	3	Done in March 06	CRAW
M 6.3.	Decision taking for coordinated experimentation during the first rainy season.	6	4	6	CRAW
M 6.4.	Production of site specific diagnosis reports.	6	10	14	CRAW & Cirad
M 6.5.	Post rainy season workshop for adjusting activity.	6-5	13	Done in November 06	CRAW & Cirad
M 6.6.	Decision taking for coordinated experimentation during the second rainy season, month16	6	16	Scheduled 14	CRAW
M 6.7.	Production of site specific experiments reports, month 22	6	22	22	CRAW
M 6.8.	Post rainy season workshop for preparing synthesis, month 25	6-5	25	22	CRAW & CIRDES
M 6.9.	Result analysis and final report per activity, month 30.	6	30	30	CRAW
M 6.10.	Final workshop among stakeholders to discuss the results and to identify the global added value,	6	35	35	Cirad & CRAW

There is a close agreement between due and delivery dates.

Section 3 – Consortium management

Consortium management tasks and their achievement; problems which have occurred and how they were solved

The FONIO project, which duration is 3 years, is led by Cirad (participant n°1). Cirad is responsible for the overall management/co-ordination of the project through WP7 undertaking three main activities:

Setting-up of the project management structure, implementation and follow-up

Cirad play the role of interface between Partners and European Commission and manage the overall legal, contractual, financial and administrative aspects according to the contract rules and consortium agreements terms.

At the beginning of the project, the co-ordinator organised the project kick-off meeting that was held in Bamako, Mali, from 20 to 24 March 2006. A steering Committee was set up to help the general coordinator for the overall management of the project through annual meetings. This Steering Committee (SC) is composed of WP leaders plus national co-ordinators when an institution is not WP leader but only deputy.

During the first half of the year, a Consortium Agreement was drawn up in accordance with EU requirements, discussed and signed between all partners to specify all their responsibilities and duties concerning this project.

The coordinator is supported by two services of Cirad (named "Service d'Appui à la Gestion" and "Service Valorisation"). The support services deal with the receipt, allocation and transmission of the Commission's financial contribution to the project partners. They are the permanent contact point for the Commission concerning payments, cost statements and general questions regarding accounting, financial and legal matters for the project.

Implement an effective project communication and reporting

During this year, a web site (http://inco-fonio.cirad.fr/) was created to assist management (communication flow within the consortium) and disseminate information outside the consortium.
Several web pages have also been produced on Cirad or European Union sites.

Communication and reporting were also implemented through different meetings and workshops organized during the year 2006.

Project monitoring and evaluation

The different tasks, workpackages, protocols, …. were discussed during the kick off meeting at the beginning of the project and during the specific workshops held during the year;

Information from WP leaders or participants regarding progress of the activities has been reported commonly to the project co-ordinator. These progress notes (usually send by email) contain a review of: the works carried out and the results obtained or of the technical and financial problems temporarily encountered. An evaluation of the project progress was done during the annual meeting held recently (December 2006) in Montpellier (France)

During the first reporting period, the consortium management does not face major problems on scientific, technical or administrative level as well because all participants involve efficiently in the project. The only difficulty has concerned, in the WP6, the choice of seeds for on-station experiments in Guinea and Mali. The Guinean teams have collected 12 popular fonio varieties in Guinea while Malian team has used old seeds with poor germination potential. This leads to some difficulties in terms of results comparison for 2006. To solve this problem, a short WP6 meeting is planned in February 2007 in Bamako to distribute varieties and to finalize protocols for the next agricultural campaign.

Contractors: Comments regarding contributions, changes in responsibilities and changes to consortium itself , if any

Between June and December 2006, a Consortium Agreement was drawn up, in accordance with EU requirements, and discussed and signed by all partners. This Consortium agreement contains 22 articles and aims to specify all the responsibilities and duties of each contractor concerning this project. The Consortium Agreement reminds the organisation of the FONIO project and gives information about costs, budget and payments, intellectual property rights and liabilities of the Contractors. Its annex gives also data concerning allocation of resources to partners, payment tables and contact persons for administrative and financial matters.

In order to facilitate the relationship between the different partners, each organisation elected a team leader. The role of the team leaders is:

- To organise the work of the different participants of the FONIO project in the country.
- To carry out the syntheses of the activities led by country and to ensure that scientific and financial reports are finalised at the appropriate time.
- To prepare and animate the co-ordination meetings and the technical workshops in the country meet in close cooperation with the coordinator.
- To ensures the necessary relationships to integrate the FONIO Project at a national level.

The team leaders are listed in the table below:

Country	**Contractor organisation**	**Team leader**
France	Cirad	Jean-François CRUZ
The Netherlands	Wageningen University	Mrs Inge BROUWER
Belgium	CRAW	Didier STILMANT
Mali	IER	Dore GUINDO
Guinea	IRAG	Thierno Alimou DIALLO
Burkina Faso	CIRDES	Eric VALL
Senegal	ENDA Graf	Babacar TOURE

Every representative of the national institution has the empowerment from his company to commit staff and other resources required by the project.

For the Research activities and as defined in the FONIO project document, the different participants are leaders or deputy leaders of the workpackages as described in the following table

Participants	**WP1**	**WP2**	**WP3**	**WP4**	**WP5**	**WP6**
1 – Cirad (France)	Co Mrs G. FLIEDEL		Co Mrs S. DURY	Vco Mrs S. DURY		VCo F. FOREST
2 – WU (The Netherlands		Co Mrs. I. BROUWER				
3 - CRA-W (Belgium)						Co D. STILMANT
4 – IER (Mali)	Vco D. DRAME					
5 – IRAG (Guinea)					Vco T.A. DIALLO	
6 – CIRDES (Burkina)		Vco E. VALL (*)			Co E. VALL	
7 - ENDA-Graf (Senegal)			Vco B. TOURE	Co B. TOURE		

Co: WP Leader, Vco: WP deputy leader (*) for nutritional value of fonio straws

Table 15: Contractors involvement in different workpackages (name of leaders)

The Workpackage leaders have the scientific and technique responsibility of the all tasks of their WP. Workpackage leaders are helped by a deputy leader who is fully conversant with the WP and deputise in the absence of the leader.

During the first year, there were not significant changes in the organization envisaged during the elaboration of the FONIO project and which came into force during the kick off meeting in March 2006. This organization seems to suit all the partners and was confirmed during the annual meeting which was held in Montpellier in December 2006

Project timetable and status, including an updated, frontlined barchart.

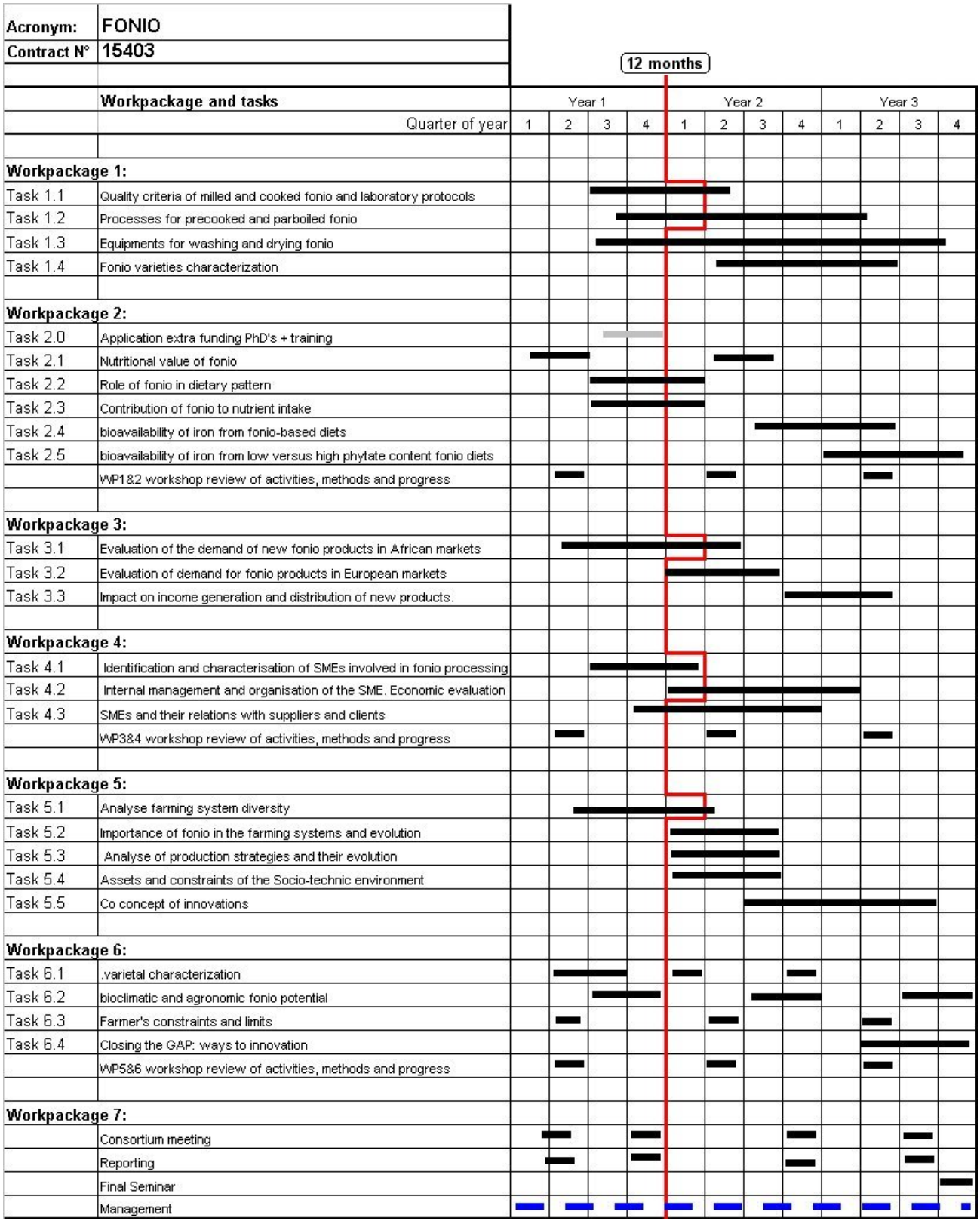


Table16: FONIO project timetable

For some tasks, there are some changes in the timetable corresponding to a delay of 3 months mainly due of the fact that the real start of the project took place in March 2006, although the official date was 1 January 2006.

Co-ordination activities in the period, communication between partners, project meetings, possible co-operation with other projects/programmes etc.

The general coordinator of the FONIO project was assigned to Cirad in Bamako (Mali) in February 2006. This central geographical position allows a better communication with West African partners. During this first year, while the general coordinator had a permanent contact with IER (Mali), he visited CIRDES (Burkina Faso) in June 2006); ENDA Graf (Senegal) in July and October 2006 and IRAG (Guinea) in October 2006. During these visits, the working programme of each institution was discussed and preliminary results were presented.

During this first reporting period, the first three months of operations were primarily given over to funding aspects (opening of accounts by partners, transfer of funds, etc), defining administrative and financial procedures and preparing and holding the project kick-off meeting.

Kick-off meeting

The project kick-off meeting was held in Bamako, Mali, from 20 to 24 March 2006.

The meeting, which was organized jointly by Cirad and IER, was attended by some forty people from the various partner organizations in Europe (France, the Netherlands and Belgium) and West Africa (Mali, Guinea, Burkina Faso, Senegal and Benin), and representatives of the private sector in Mali: AOPP (Association des Organisations Paysannes et Professionnelles), FENATRA (Fédération Nationale des Transformateurs) and SMEs (processors, women's groups, EIGs, etc).

This meeting in March 2006 marked the real start of the project. It was led by the project's overall coordinator (J.F. Cruz) and chaired by Dr Oumar Niangado, and set out to present the different partners in the project, finalize the annual programme of activities for 2006, and determine the strategies to be adopted to achieve the objectives set by the project. It was also very useful for creating links between the various researchers present and facilitating future collaboration. Lastly, the first workshops for WPs 5 and 6 were also held during the meeting.

CDrom of all the papers presented during the meeting was realised and distributed to the partners and to the representatives of the private sector

Fig. 26: FONIO kick off meeting and CD-Rom

Specific meetings.

The first workshops for WPs 5 and 6 were held during the Kick-off meeting in Bamako in March 2006.

The first WP1 to WP4 workshop, organized jointly by Cirad and ENDA Graf, took place in Dakar (Senegal) June 26-30, 2006. This meeting was attended by about a dozen people from Cirad (Montpellier and Bamako), IER (Bamako), IRAG (Kindia), Université Abomey Calavi (Cotonou) and ENDA Graf (Dakar).
This workshop was very helpful to establish the relationships between the WP1 to 4 scientists coming from various backgrounds: food technology, nutrition, process engineering, mechanization, social sciences and to define the precise activities of each Wp for the following six months. This meeting was the real starting date for most of WP1-4 activities.

A “post rainy season” workshop of WP5 (farming systems) and WP6 (cropping systems) was held in Guinea in Fouta Djalon (IRAG Centre of Bareng) and in Kankan (IRAG Centre of Bordo) from October 31 to November 4, 2006, then in Mali (IER Centres of Sotuba and Cinzana) during 4-9 November, 2006. It was attended by twenty or so people (agronomists, specialists in cropping and farming systems…) from Belgium (CRAW), France (Cirad), Burkina Faso (Cirdes), Guinea (IRAG) and Mali (IER and Cirad).

This workshop gave the opportunity to submit and discuss the results obtained by the WP 5 & 6 during the year 2006 and to define the adjustment to perform during the next rainy season. It was also possible to discuss and prepare the activities syntheses and the "délivrables" and to visit on-station and field experiments in different sites.

Clichés J.F. Cruz

Fig. 27: Visit of experimental plots during WP5&6 workshop in Guinea (Bareng) and in Mali (Sotuba)

Annual meeting

The annual meeting of FONIO project took place in Cirad - “Maison de la Technologie” in Montpellier (France) from the 4 to December 8, 2006. It was organized by the Cirad project coordination team and followed by about twenty people: the steering Committee i.e. the workpackage leaders and the team leaders coming from Mali (IER), Guinea (IRAG), Senegal (ENDA Graf), Burkina Faso (Cirdes), Holland (University of Wageningen) and Belgium (CRAW) and also researchers and technicians of Cirad-Montpellier which take part in the activities of the project

The aim of this annual meeting was:

- To present the scientific activities carried out during the first year (2006)
- To prepare and plan the activities for the second year of project
- To work out the annual scientific report
- To give a progress report on the budget and the financial statement

The report is under finalization

Next meetings or workshops

As the FONIO project aim is to promote work "in the field" and to strengthen the relationships with the private sector, an important part of the European scientists work consists in research and support missions in the DCs. Project management partially operates on the basis of the planning of coordination meetings and scientific workshops. The table below here gives the updated provisional meeting calendar

Meetings	Country	Participants	Month	Duration (days)
Start-up coordination meeting	*Mali*	*Steering Committee + local staff involved*	*3*	*4*
WP5 and WP6 workshop	*Mali*	*Researchers involved*	*3*	*2*
WP1,WP2,WP3 & WP4 workshop	*Senegal*	*Researchers involved*	*6*	*5*
WP5 and WP6 workshop	*Guinea & Mali*	*Researchers + staff involved*	*3*	*15*
Annual coordination meeting	*France*	*Steering Committee + local staff involved*	*12*	*4*
WP6 "pre rainy season" meeting	Mali	Researchers involved	14	2
WP3 –WP4 workshop	Mali	Researchers involved	18	5
WP1 -WP2 workshop	Mali	Researchers involved	21	5
WP5 and WP6 workshop	Burkina	Researchers involved	22	5
Annual coordination meeting	Belgium	Steering Committee + local staff involved	23	4
WP1 and WP2 workshop	Netherlands	Researchers involved	25	5
WP3,WP4, WP5, WP6 workshop	Guinea	Researchers involved	25	5
WP1, WP3 and WP4 workshop	Senegal	Researchers involved	26	5
Final annual meeting	Burkina	Steering Committee	35	4
Final seminar	Mali	Steering Committee + researchers involved + NGOs + GOs + etc	36	4

Table 17: Updated FONIO meetings timetable

Collaboration with other projects/programmes

During this reporting period, some researchers, because of to their expertise acquired in knowledge of fonio have established relations with other projects or institutions located in West Africa.

- Collaboration with an NGO in Mali which aim to improve the fonio commodity chain in the zone of Kenieba (near the border with Guinea). In this zone, some producers recently met in association in order to improve the production, the processing and the marketing of fonio through the fair trade label named "Ethiquable". One of the activities of the Ngo is to improve the post harvest technologies (processing, drying,..)

- Collaboration with a Spanish NGO (Intervida) located in Mali which plan to develop a Food project for food security of the rural populations near the Niger river (Ségou region). They want to develop the culture of fonio on lateritic ruined agronomic zones to gather food stocks for local populations and commercialize surpluses.

Collaboration with the Dynafiv ("dynamisation des filières vivrières") project in Guinea. This project develops macroeconomic approach to driven commodity chains (i.e. fonio) and gives assistance promoting discussions, training and information to stakeholders. During his mission in Guinea, the coordinator discussed with the project leaders, the way to collaborate on the fonio channel (mainly about commercialization).

Web site

The web site of the FONIO project was created by Cirad in April 2006. The Web site is available in French and in English and its URL is http://inco-fonio.cirad.fr/. (or http://inco-fonio-en.cirad.fr/ for the English version). The web site has a reserved section for the only contractors of the project (members only) on which are diffused all internal or confidential information.

Fig. 28: Inco-Fonio web site

The statistics illustrated by the histogram below show the numbers of visits per month and the trends along the year. In December 2006 the web site has received about 491 visits.

The web site is updated as frequently as possible with the information provided by each contractor

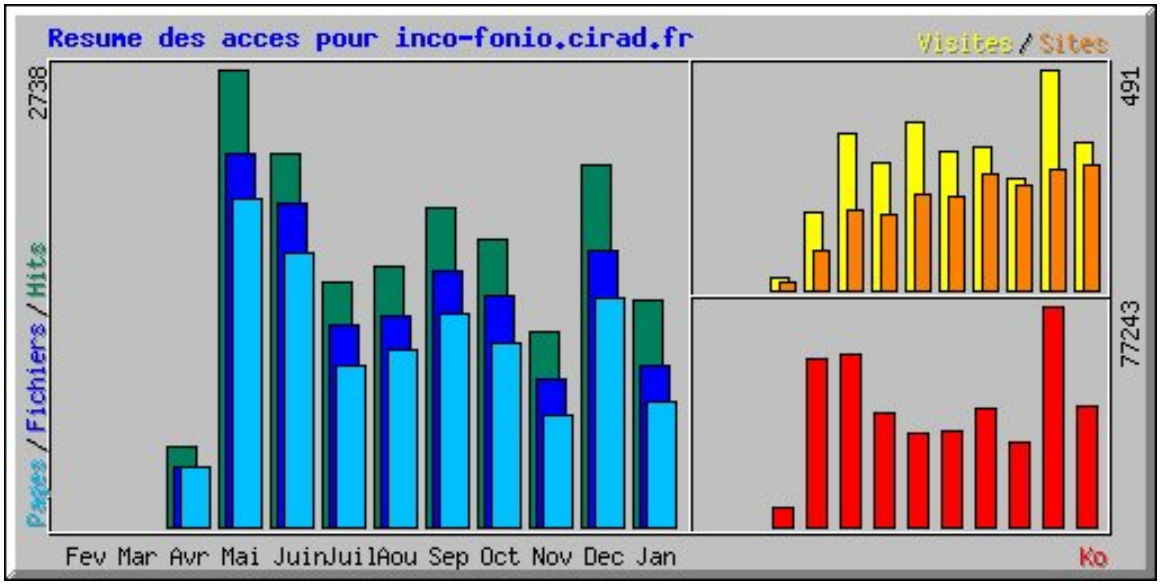


Table18: Histogram of numbers of visits (hits, …) per month of the Inco-Fonio web site

List of deliverables, including due date and actual/foreseen submission date

é

Del N°.	Deliverable name	WP N°.	Date due	Actual/ Forecast delivery date	Estimated indicative person-months *)	Used indicative person-months *)	Lead contractor
41	Annual and Final reports	7	13, 25, 37	15,26,37			Cirad
42	Web site	7	6	4			Cirad
43	CD Rom (compilation of the main scientific and technological results)	1	37	37			Cirad

List of milestones, including due date and actual/foreseen achievement date

Milestone no.	Milestone name	WP n°.	Date due	Actual/Forecast delivery date	Lead contractor
M7.1.	Inaugural meeting to initiate the action and define in details the strategy.	7	1	Done in March 06	Cirad
M7.2.	Annual co-ordination meetings Month 12 and month 23.	7	12, 24	Done in Dec 06 Scheduled 23	Cirad
M7.3.	Participation to scientific and technical workshops Month 3, 6, 13, 18, 25, 26.	7	3, 6, 13,18, 25,26	Done in March &June 06 Done in November Scheduled 14,18, 21,22, 23, 25,26	Cirad
M7.4.	Final annual meeting	7	33	35	Cirad
M7.5.	Final Seminar.	7	35	36	Cirad

Appendix 1 – Plan for using and disseminating the knowledge

Section 1 – Exploitable knowledge and its Use

The first exploitable knowledge in terms of equipments will be the dissemination and use of the driers but, at this stage of the project, this is not yet applicable because we are still under experiments.

Section 2 – Dissemination of knowledge

Very few results were available by the end of this first operational phase. This is quite normal, since the first year was primarily given over to setting up the project in the field, collecting plant material for the first trials on experimental stations and conducting the first surveys of producers, processors and consumers.

The most important advance in terms of disseminating information was the launch of a website four months after the kick-off date. Its URL is http://inco-fonio.cirad.fr/. (or http://inco-fonio-en.cirad.fr/ for the English version).

Several web pages have also been produced on the European FONIO project:
"CIRAD" page
http://www.cirad.fr/en/actualite/communique.php?id=501

"European Union" pages
http://ec.europa.eu/research/headlines/news/article_06_09_22_en.html
http://cordis.europa.eu/fetch?CALLER=EN_NEWS&ACTION=D&SESSION=&RCN=26409

Overview table

Planned/ actual dates	Type	Type of audience	Countries addressed	Size of audience	Partner involved
April 2006	Project Web site	General public Researchers	All countries	About 500 visits /month	Cirad
June 2006	Research show (SMARA)	Researchers	Mali	100	Cirad IER
June 2006	Leaflets	Researchers Stakeholders	West Africa Europe		Cirad
November 2006	Agricultural show SIAGRI	General public Researchers	Mali	300	IER
Planned	Posters	Researchers General public	West africa		All partners
Planned	Publications	Researchers	international		All partners
On going	Database	Researchers	West africa		Cirdes
Planned	Film video	General public	international		Cirad
On going	Technical reports	Researchers Manufacturers	All countries		Cirad & IER
Planned	Articles	General public	international		All partners
Planned	Drawings Demonstration	Manufacturers Processors	Mali		IER/Cirad
Planned	Conference	Researchers Stakeholders	West Africa	50-100	All partners

Table: Overview table to disseminate knowledge

Web site
The web site is updated periodically with the information provided by each contractor. To increase the web site audience, each partner is encouraged to create a link to fonio web site on his own organisation web site and to participate as frequently as possible to scientific or technical exhibitions in order to present the FONIO project.

Agricultural show
Another activity to disseminate knowledge concerned participation to agricultural shows:
- Participation of Cirad and IER to SMARA (Semaine de la Recherche Agricole du Mali) during one week in Bamako June 2006
- Participation of IER to SIAGRI (Salon International de l'Agriculture) during one week in Bamako (Mali) in November 2006.
Research scientists will attempt to present the FONIO project and the results obtained in the countries where national or regional agricultural shows are organized, (Burkina, Senegal, Mali,..). This also might be an opportunity to inform a large public through television, radio or newspaper interview.

Leaflets
Leaflets presenting FONIO project and fonio processing were elaborated and given to some stakeholders, processors who participate to international meetings (i.e. UCODAL firm has participate to the first « fair trade show » in France, Aubagne November 2006) or to visitors or guests (UEMOA parliamentarians visiting Sotuba IER Station in august 2006)

Posters
Posters presenting activities and results of FONIO project will be presented on national or international meetings.

Publications
Scientific papers presenting research results obtained within WPs will be published in international journals or through national or international conferences.

Database
A regional database on the farming systems integrating the fonio is under elaboration by CIRDES

Video film
During the project period, we wish to produce a video presenting all the phases or steps of the fonio commodity chain.

Technical reports
During all the project period, technical and specific reports will be produced after each step passed by the research teams. These reports will be used by students and research teams to progress in their activities. Some of these technical reports could be used by stakeholders as technical guides.

The technical notes or reports produced during this first reporting period are the following

WP1
- Pariaud M. 2006. Mise au point d'équipements et de protocoles pour l'étuvage du fonio. 30 juin 2006, DUT Génie des Procédés Université A Lyon I, 90 pp.
- Marouzé C. and Dramé D. 2007. Projet FONIO. WP1- Activité 3 : Équipements de séchage de fonio. Compte rendu des travaux du CIRAD avec la collaboration de l'IER. 18 p.

WP2
- Report of first workshop Working Package 2, 12-16 June, 2006
- Fanou N. Study proposal: Importance of fonio in the dietary pattern in Mali. Part 1: assessment of the general food intake pattern. June 2006

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Demonstration

Demonstration of the use of various equipments elaborated within the WP1 (driers, …) will be organized for stakeholders and mainly processors and manufacturers. The transfer of drawing and exploitable result will then be discussed with manufacturers interested

Conference

At the end of the project period it is planned to organize a conference in Mali to present and submit the results obtained by FONIO research teams within the different workpackages. This conference will be attended by researchers, stakeholders, NGOs, etc..

Section 3 – Publishable results

Not yet available at the end of the first reporting period.