



Executive summary (year 2)

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 avoid 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.

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Work completed

Co-ordination and management

The first annual coordination meeting was held in Cirad Montpellier, France, from 4 to 8 December 2006. Organized by the Cirad project coordination, this meeting was attended by about twenty people (Steering Committee and scientists) coming from Mali (IER), Guinea (IRAG), Senegal (ENDA Graf), Burkina Faso (Cirdes), Netherlands (Wageningen University), Belgium (CRAW) and France (Cirad). The meeting was dedicated to present and analyse the first research results obtained during the first year and to prepare and plan the scientific activities for the second year of the project.

During year 2007, the first 2 months were devoted to reports writing (first activity and first management reports) with collaboration of WPs and team leaders. Then different meetings were organized during the year: "WP6 meeting" in Bamako (April, 3-4/2007), "WP3&4 workshop" in Bamako (May 29- June 2/2007), "WP5&6 workshop" in Mali and Burkina Faso (October 16- 26/2007), "WP1 to 4 workshop" in Bamako (Oct. 29- Nov. 3/2007). Two specific missions were also realised: in Mali and Burkina Faso (March 6-13/2007) to study fonio precooking and in Guinea (April 16-27/2007) to analyse the Guinean fonio commodity chain in collaboration with WP3 and WP4.

Lastly, the second annual coordination meeting took place at CRAW Center (Walloon Center of Agricultural Research) in Libramont (Belgium) on 25-29 November 2007. This meeting was attended by the project Steering Committee with representatives of each partner. The 4 days meeting was dedicated to present and analyse the research results obtained during the second year, to prepare the activities for the last year of the project and to plan the submission of reports and deliverables.

Nota bene: The scientific coordinator of the project (J.F. Cruz) based in Bamako (Mali) since the beginning of the project joined Cirad Montpellier (France) on September 1, 2007.

Research activities

Research Activities were conducted in the framework of the 6 thematic work packages. Activities of WP1 to WP4 were going on all along the year while WP5&6 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)

WP1, coordinated by Cirad (France), concerns “Diversification of fonio products for niche export markets and local markets”. During 2007, workpackage 1 focused on task 1.2. with the optimization of parboiling process at laboratory level. A diagram was developed in Cirad laboratory using small quantities of grain and analytical methods were adopted. Preliminary experiments were conducted to define study limits of influent factors before running a Doehlert experimental design with three factors and 15 experiments. Response surface methodology and desirability function were used to define optimal conditions to get a good technological quality product. Other parboiling tests were carried out in parallel in IER controlled conditions to study the effect of soaking water pH, temperature and soaking time on paddy grain water content and milled grain colour. In Mali and in Burkina Faso, tests were implemented at SME level to increase knowledge of traditional precooking and to draw up the diagram of fonio precooking. Task 1.3 focused last year on the manufacturing of two driers : a counter current cross-flow gas drier (CSec-T) and a greenhouse ventilated solar drier (CSec-Serre or “Fama”), continued the second year through experiments conducted in local enterprise conditions during two different seasons (dry and humid). Their performances were compared to that of other gas and solar driers. Processors were asked to validate these equipments. Task 1.4. started the second year with the analysis of 54 fonio ecotypes collected by WP6 and WP5 in Mali, Guinea, Burkina Faso. These varieties were characterized at physical and biochemical level. Their dehulling, milling and cooking properties were determined. A Principal Component Analysis run on five quality traits showed a variability of these traits among the ecotypes per country.

Wageningen University is leading WP 2 “Nutritional aspects of fonio and fonio products”. The activities of WP2 in 2007 were mainly focused on implementation of 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). Samples of fonio varieties and fonio products were collected and prepared for biochemical analysis. Food consumption studies (24 hour recall and food weighed records) were carried out among 100 and 30 women of reproductive age in Bamako respectively. Nutritional status and blood sampling was carried out among 67 women. A study on the identification of factors predicting the consumption of fonio among women of reproductive age in Bamako was carried out. Nutritional status of these women was determined and blood was withdrawn of the women to determine iron status. The Mali food composition table was updated. Preliminary data show that iron deficiency is highly prevalent among women of reproductive age in Bamako, probably due to a low iron intake from the diets. Women do consume fonio, but frequency and portion size of fonio is low. Fonio consumption could be promoted by focussing on positive attitudes towards fonio consumption, emphasizing general health consequences of fonio consumption and by reducing the barriers to consume fonio. Whether iron status could be increased by increasing fonio consumption is depending on iron and phytate level of fonio and fonio products, and the effect on these by parboiling.

WP3 led by Cirad concerns “demand for new products and its effects on income generation and distribution”. During 2007, the processing of data (price paid for quality characteristics and profile of consumers) collected in 2006, in Bamako, was finalized within the framework of the task 3.1. (demand for new products in Africa). It was shown that the market of new products (milled and washed or precooked fonio) reached different consumers from those who usually buy decorticated or milled fonio. They were more often men and they have usually a high level of education and status. A paper about the valuation of quality attributes on the retail market in Bamako was published. A new survey focused on potential consumers of precooked fonio in Bamako was launched in November. Concerning task 3.2 (demand for new products in Europe), a survey about the demand for new products and new quality attributes (fair trade, organic, etc) was realised in Montpellier (France). The results showed that, on average, consumers tend to look for beautiful packages, with information and labels. The multiplication of labels is attractive for most consumers, except for label: “small farmers” and “African origin” at the

same time. The test of recipes showed that non connoisseurs of fonio do not succeed 50% of the time. An effort on recipe still has to be done. The results suggested to find simple recipes such as “polenta” (soft porridge) adapted to south European food habits. Concerning the market chains (task 3.3), new surveys and interviews were done with small scale processors and different stakeholders of the market chain in Mali and in Guinea. A first assessment of the jobs created by producers of precooked fonio and the millers was done. Difficulties were encountered to draw a comprehensive map of the market chain, and to assess the margins of the different stakeholders.

WP4 is led by ENDA Graf (Senegal) and concerns “small firms and innovation in terms of products and processes”. Fonio producing MSEs that developed in the recent years are confronted to major contradictions, including the desire to expand in environments where fonio itself is more or less marginalized by public policies and the departments of agriculture of the respective countries. But the impacts in terms of social and economic dynamics are real. A female leadership has been consolidated in the management of the sector. Women are more present in collecting and distributing finished products. Over 90% of companies are led by women and most of the people mobilized for SME activities are women. They share about 70% of the generated incomes, which are still low however. Fonio seems to become a niche. But several constraints including the removal of the sand, washing, the development of networks of qualified workers for the construction and dissemination of equipment, the technical and financial capacity of enterprises, regular and quality supplies, the better control of distribution networks, are challenges still to overcome.

WP5, directed by CIRDES (Burkina Faso) is named “Opportunities of diversification and multiple uses of fonio in production systems”. In 2007, the diversity of fonio producers in Guinea, Mali and Burkina Faso was characterized in accordance with the agro-climatic zones (food shortage farming in semi-arid zone, crop diversification farming in the sub-wet zones). The mode of fonio farming was characterized by a monitoring of farming lands in Guinea, Mali and Burkina Faso (farming without input, producing 600 kg/ha grain on average) as well as the factors of variations of the output (contribution of organic manure, early weeding, covering up grass, age of the field...) and identifying the intervention priorities on the exploitations and on the modes of farming. The strategies of fonio producers started to be analyzed as well as the socio-technical environment of the production of fonio (requests and service offers). Two opportunities are offered to the fonio producers: the first one is to sale on the local market, but for that to happen, farmers need to lower the selling price of the fonio by the mechanization of the post-harvest activities (threshing, dehulling); the second opportunity is to export to the “organic fair trade” markets via new economic operators and, for this market, farmers need to increase the productivity of the fonio (possible output of 1000 kg/ha) by an ecological intensification (organic manure, productive local varieties, early mechanical weeding...) to preserve its character of “organic (or biological) farming”. The experiments on the valorisation of straws and the improvement of the productivity are planned for 2008.

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.

Variety trials highlighted the large variation existing amongst the different cultivars tested. Two varieties, *Kökounin* and *Gbelen* from the early heading group presented good performances in the two experimental sites in Guinea. In the late heading varieties, *Konso* and *Siragué* performed well. In 2007, a multi-local varieties comparison trial included 13 varieties in 4 sites (two in Guinea and two in Mali). After the adaptation of different technologies, in order to measure thousand grains weight, to scan NIRS spectra of these grains, ..., morphological and biochemical characterisation of these varieties, started in 2006, was continued in 2007 together with the characterisation of their technological value (WP1).

The analysis of 2006 results of the trials aiming to test fonio responses to photoperiod and its impact on biomass distribution has underlined the photoperiodism of this species with a flowering induction under shortening day length. Nevertheless, each variety was characterized by its own intrinsic cycle length. These data were used to calibrate the model developed by Folliard et al. (2004) to predict the shift from the vegetative to the reproductive stage of photoperiodic species.

Exploratory fertilisation trials have led to the conclusions that N, P, K fertilisation could have a positive impact on fonio production. 2007 trials focussed on NPK fertilisation of the Fonio in crossing three levels (0, 15 and 30 units/ha), of each nutrients. The three experimental sites were Bordo and Bareng, in Guinea, and Cinzana in Mali.

The exchanges with fonio producers underlined that both fertilisation and weed control within fonio crops have to be elaborated in the context of the crops rotation scheme. Difficult after fallow, control is possible when this crop comes after a leguminous species profiting from the back effects of the rotation head (Sorghum, Millet,...) if they received manure. Such rotation scheme seems to maintain enough fertility for the fonio in order to reduce the pressure exerted by *Striga hermontica* occurring mainly on poor soils.

Dissemination of knowledge

Fonio producers and processors are the final target of the FONIO project and need to be informed about the different tasks. The implementation and the first results of the research activities have been presented to different stakeholders during the specific workshops organized during the year. So, during the WP3&4 workshop on May in Mali, some processors from Bamako were invited to participate to the meeting. During the “post rainy season” workshop on October in Mali and Burkina Faso, project’ staff met producers leaders in some villages to present FONIO project. On April, during a mission in Guinea, the Project coordinator and scientists from WP3, WP4 and WP6 got also the opportunity to take part in a documentary on fonio processing and to participate in a radio programme about fonio channel in Guinea. This radio programme will be diffused to a large audience by local rural radio stations in the country.

For other stakeholders (professionals, scientists, policy makers, decisions makers,...), project leaflets were distributed during meetings (e.g. with Agriculture Minister in Guinea, with The French ambassador in Mali, ..) or during Agricultural or Scientific Shows (SIAGRI and Smara in Mali, ...). Some papers or posters were also published:

Dury S., Meuriot V., Fliedel G., Blancher, Boré Guindo F., Dramé D., Bricas N., Dialité L. et Cruz J.F., 2007. The retail market prices of fonio reveal the demand for quality characteristics in Bamako, Mali. Communication at 106th seminar of the European Association of Agricultural Economists "Pro-poor development in low income countries: Food, agriculture, trade, and environment", Montpellier, France, 25-27 October, 15 p.

Koreissi Y., Brouwer I., Hulshof P., Zimmermann M., 2007. Nutritional aspects of fonio and fonio products. Poster in 7th International food data conference. Food Composition and Biodiversity. Sao Paulo, Brazil, October 21-24, 2007.

For larger public information, the WEB site is developed (<http://inco-fonio.cirad.fr>) and, since the beginning of the project, several web pages have also been produced on the European FONIO project:

“Cirad” or Agropolis pages

<http://www.cirad.fr/en/actualite/communiqu.php?id=501>

http://umr-qualisud.cirad.fr/projet_de_recherche/axe_1_theme_1_1/amelioration_de_la_qualite_de_la_filiere_fonio

www.agropolis-international.net/pdf/lettre/lettre_122.pdf

“CRAW” pages

<http://www.cra.wallonie.be/module/newsletter/index.php?ID=76&Action=view>

www.cra.wallonie.be/module/craw_info/craw_info_pdf/craw-info-16-2007.pdf

“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

Other Web pages

http://www.underutilized-species.org/record_details.asp?id=701

<http://www.underutilized-species.org/MasksSearch/SearchProjectDetail.aspx?id=227>

<http://www.seedquest.com/News/releases/2006/august/16742.htm>