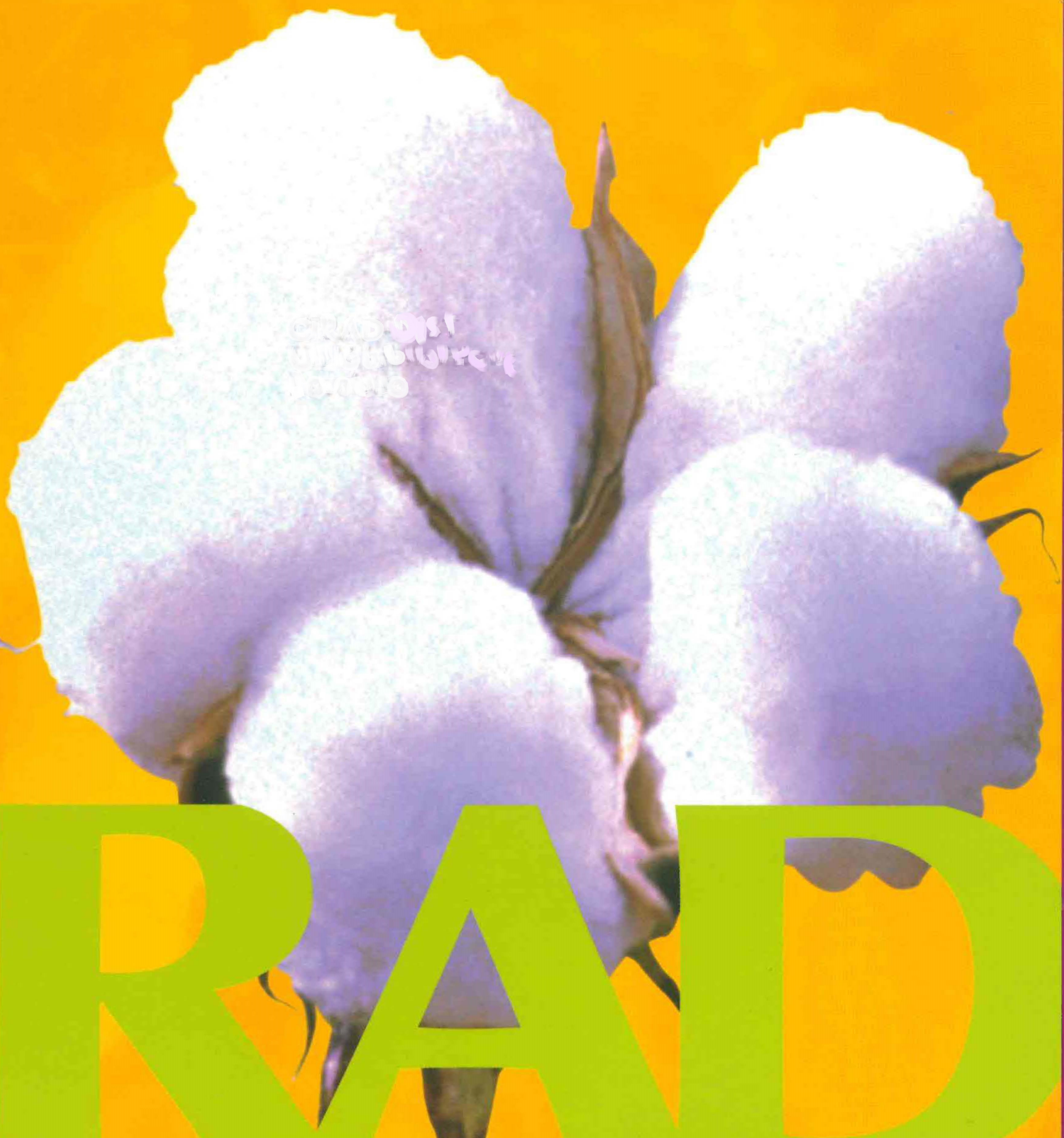
COTTON showcased at CIRAD



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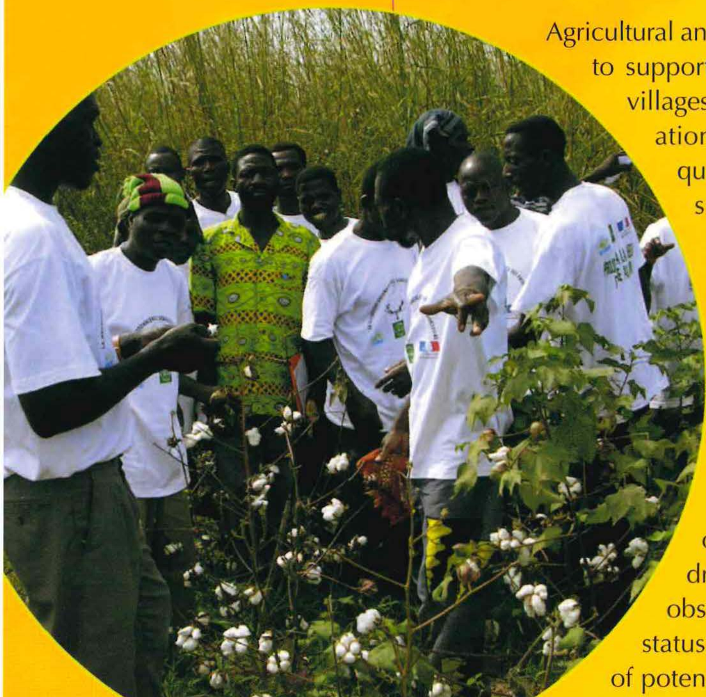
Participatory research—bridging the gap between farmers and scientists

CIRAD is now supporting institutional changes in cotton subsectors through its involvement in participatory activities in closer collaboration with farmers. Several programmes have been under way with the national agricultural research institute in Benin since 1996, and with the agricultural research directorate in Paraguay since 2000. Research, cooperation and training systems are being tested through these programmes. They are designed to bind ties between scientists of national agricultural research systems and farmers who benefit from the research.

Agricultural analysis and farmer field schools in Benin

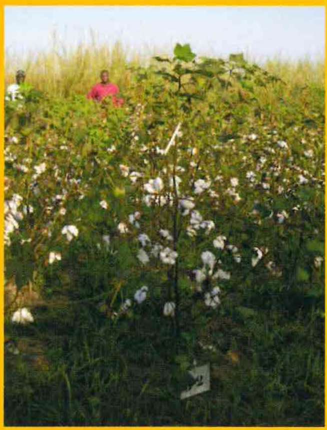
Agricultural analyses are being carried out within the framework of PARCOB (project to support cotton research in Benin) on 250 farmers' plots in 10 different villages to assess the complex relationships between farmer's cropping operations and cotton production results (seed cotton yields and fibre quality). In the northern provinces of Benin, the number of bolls per surface area is the key yield component, as mainly determined by the sowing date and extent of crop protection.

The combination of farmer field schools and this type of field performance analysis provides a very effective training tool. It can be used to detect and classify problems facing farmers, while instructing them on adopting a rational and responsible attitude concerning crop protection, etc. The group training sessions conducted in farmers' fields could thus involve cultivating healthy plants, monitoring insect populations and distinguishing the action of beneficial organisms. The farmers are then asked to make drawings illustrating certain aspects of the life cycle of cotton plants, observed damage or pests, and insects present (sometimes of unknown status). These drawings can spark group discussions on the suitability of potential pesticide treatments.



A group of farmers evaluating new lines in a varietal trial.
© J. Lançon

Participatory breeding and assessment in Benin and Paraguay

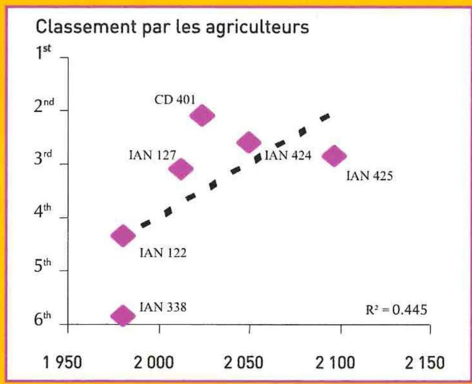


Okpara 3-4 line, highly rated by farmers.
© J. Lançon

Savalou 4-33 line, rejected by farmers.
© J. Lançon

In Benin, the decentralized cotton breeding programme has highlighted that farmers are able to carry out field breeding initiatives that are as relevant as those managed by scientists, but laboratory breeding is still essential for assessing quality criteria. In the light of these promising results, cotton farmers' organizations have taken over the programme and are enhancing the sustainability of the system and broadening its scope.

Farmers' classification of six cotton varieties relative to the seed cotton yield (kg/ha) in Paraguay.



In Paraguay, cotton farmers have been formally associated directly with the evaluation of cotton varieties prior to their release, and highly involved in the testing. They validated a so-called "base-satellite" design to analyse the results of multi-location assessments under controlled conditions in terms of information supplied by a network of farmers who have actually cropped these varieties in their fields.

An approach that makes sense

The results of these experiments in Benin and Paraguay highlight the relevance and effectiveness of a participatory approach to cotton research. They show that such mechanisms can bind links between research and users while boosting confidence at a time when the subsectors are threatened by the shutdown of cotton companies.

Partners

INRAB, Institut national de recherche agronomique du Bénin, Benin

DIA, Direccion de Investigation Agricola, Paraguay

For further information

Lançon J., Lewicki S., Viot C., Djaboutou M., Cousiño J.C., Sêkloka E. 2006. Recréer du lien dans les filières cotonnières : la sélection participative au Bénin et au Paraguay. Cahiers Agricultures 15 (1): 92-99.

Lançon J., Lewicki S., Djaboutou M., Chaume J., Sêkloka E., Assogba L., Oriu Mousse D., Bio I., 2004. Decentralized and participatory cotton breeding in Benin: Farmer-breeders' results are promising. Experimental Agriculture 40 (4): 419-431.

Deybe D., Vaissayre M., 2000. Are farmer field schools an appropriate training tool for integrated pest management? The case of rice farmers in Indonesia. CIRAD, Working paper 46, 12 p.

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H2SD and SCT—Cotton stickiness detectors

Postharvest trash contamination, such as honeydew deposited by certain insects, reduces the market value of cotton fibre. Sticky fibre may clog spinning mills, resulting in breakdowns, production losses and poor quality end products. It is essential for both producers and spinners to be able to accurately measure cotton stickiness so as to optimize the bale binding process. CIRAD thus invented two stickiness measuring instruments—the SCT thermodetector and the high-speed H2SD detector.

Detectors implemented worldwide

More than 100 SCT thermodetectors have been sold since 1988. This detector is currently being certified by the European Committee of Standardization (CEN) and is recommended by the International Textile Manufacturers Federation.

The high-speed H2SD detector has been marketed since 1998 and is also under CEN assessment for certification. Six detectors are presently operational in USA, France and Egypt.

These detectors are manufactured and marketed by SYDEL, a Montpellier-based company.

Fibre stickiness measurement concept

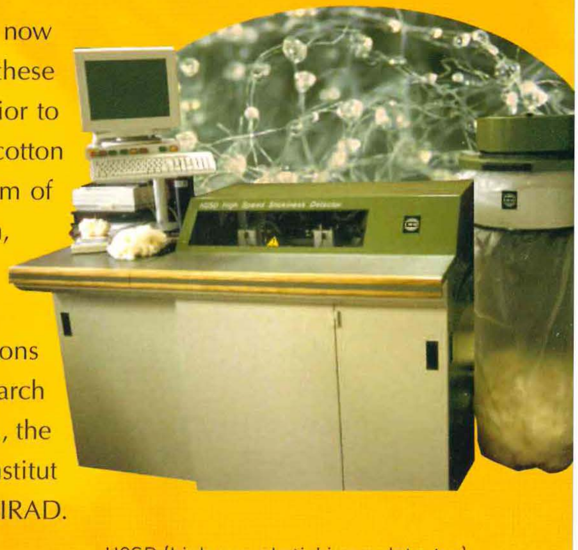
The CIRAD Cotton Technology Laboratory has invented instruments for measuring cotton stickiness to help overcome this problem in the spinning process. These instruments—the sticky cotton thermodetector (SCT) and the high-speed stickiness detector (H2SD)—were automated and tailored for industrial use.

The concept involves quickly increasing the humidity of honeydew by combining heat input and pressure applied to a cotton sample. Honeydew is deposited on a neutral substrate for visual measurement or using a system with a camera and image analysis software.

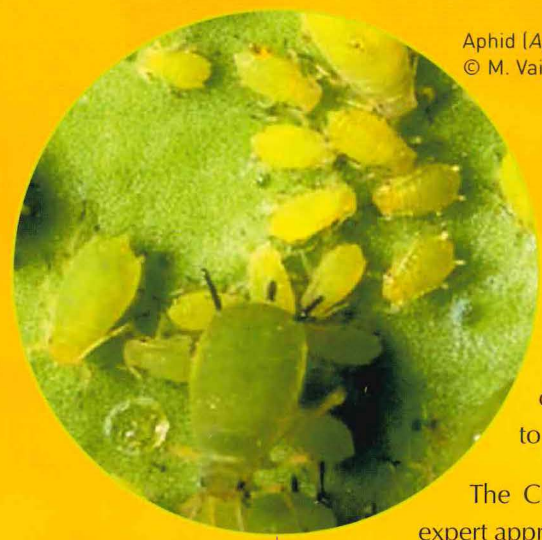
Countries hampered by the sticky cotton problem can now develop an effective monitoring strategy using these detectors and thus eliminate sticky cotton bales prior to processing. This avoids unfair devaluation of entire cotton batches on the world market. In 2000, with the aim of promoting nonsticky cotton production, the Common Fund for Commodities (CFC) funded research to improve marketing of cotton produced in regions handicapped by the stickiness issue. This research jointly involved the Sudan Cotton Company Ltd., the Agriculture Research Corporation (Sudan), the Institut français du textile et de l'habillement (IFTH) and CIRAD.

Textile manufacturers can then efficiently manage their yarn supplies, make suitable fibre blends and thus reduce spinning problems.

SCT (sticky cotton thermodetector). © R. Frydrych



H2SD (high-speed stickiness detector). © R. Frydrych
Background photo: Microscopic view of aphid honeydew on cotton fibre. © CIRAD

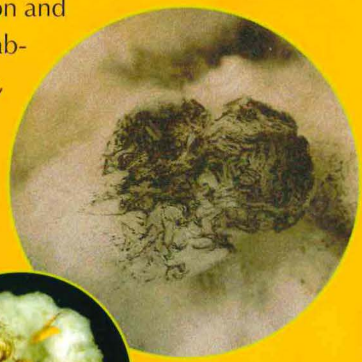


Aphid (*Aphis gossypii*).
© M. Vaissayre

An internationally renowned laboratory

This research and these inventions have had a major impact on the entire cotton industry. The scientists convey the knowledge they have acquired to stakeholders via conferences, publications and training sessions.

The CIRAD Cotton Technology Laboratory participates in expert appraisal committees on cotton contamination and supervises graduate students in their thesis research. It has established ties and contracts with partners in USA, Germany, Switzerland, Sudan, etc. The laboratory is recognized worldwide for cotton contamination assessment, with a key confirmed role in development-oriented research.



Cotton fibre contaminated by insect droppings infected by the fumagin fungus.
© R. Frydrych and T. Erwin

Partners

France: Agence nationale de valorisation de la recherche • ENSITM, Ecole nationale supérieure des industries textiles de Mulhouse • IFTH, Institut français du textile et de l'habillement, Villeneuve-d'Ascq • UHA, Université de Haute-Alsace, Mulhouse

Europe: ICCTM, International Commitee on Cotton Testing Methods, Germany; ITMF, International Textile Manufacturer Federation, Switzerland

USA: Cotton Incorporated • ICAC, International Cotton Advisory Commitee • ITC, International Textile Center

Sudan: SCCL, Sudan Cotton Company Ltd. • ARC, Agriculture Research Corporation

For further information

Bachelier B., Frydrych R., Gourlot J.P. 2004. High speed stickiness detector (H2SD): Measurements for the cotton sector. *In* Schneider T., (ed.), Heap S.A., (ed.), Stevens J.C., (ed.). Proceedings of the 27th International Cotton Conference [CD-ROM]. Bremen, Germany: Faserinstitut Bremen e.V., 29-40. International Cotton Conference. 26, 2002/03/13-16, Bremen, Germany.

Frydrych R., Gourlot J.P., Gozé E., Lebrun B., Lassus S., Nieweadomski J.C., Drean J.Y., Lekcir M., 2004. Sampling issues for stickiness measurements. [Abstract]. *In* Proceedings of the Beltwide Cotton Conferences 2002-2004. Memphis, TN, USA, National Cotton Council of America, The Cotton Foundation, 2417 (1 p.). 2004 Beltwide Cotton Conferences, 2004/01/05-09, San Antonio, Texas, USA.

Frydrych R. 2002. Les polluants du coton : cas du collage et des débris de coque. 2 vol.: 201 p., 240 p. HDR dissertation, ENSITM, Mulhouse, France.

Gourlot J.P., Frydrych R., 2002. Improvement of the marketability of cotton produced in zones affected by stickiness. Proceedings of the final seminar, Lille, France, 4-7 July 2001. CFC, Amsterdam, Netherlands, ICAC, Washington, USA, CIRAD, Montpellier, France, IFTH, Villeneuve d'Ascq, France, SCC, Khartoum, Sudan, ARC-Cotton Research Program, Wed Medani, Sudan. CFC, Amsterdam, Netherlands, 196 p. (English and French versions).

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Overcoming seed-coat fragment contamination in cotton fibre

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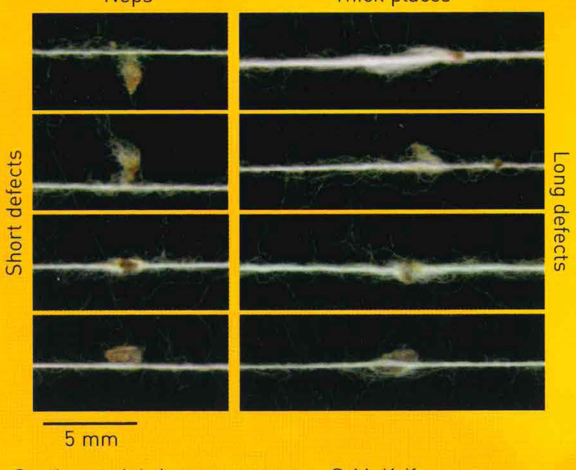
Cotton fibre contains various impurities, including leaf and stem pieces, insect droppings, whole or broken seeds, seed-coat fragments, etc. Some of this trash, such as leaf and stem pieces, is easy to remove, but seed-coat fragments are harder to eliminate because of the attached fibres. These contaminants may still be present at the spinning stage and result in production spoilage. CIRAD has developed Trashcam, an apparatus for detecting and quantifying seed-coat fragments, and its cotton breeding programmes now take this criterion into account.

What causes seed-coat fragmentation?

Cottonseed consists of a shell and a kernel. The shell has six tissue layers and each of its fibres derives from a cell in the outermost layer.

Ginning—a mechanized operation to separate the fibre from the seed—causes seed-coat fragmentation. The fragments are from fragile parts of the seed coat that are torn off or fragmented during ginning. These seed-coat fragments remain attached to the fibres they bear and are thus hard to remove during post-ginning cleaning operations. Many of these fragments are not eliminated before the spinning stage, and are subsequently found in the yarn and textiles. This trash reduces yarn strength and may lead to breakage, which diminishes the strength and appearance of the woven textile end product. Textile manufacturers have therefore become more demanding with respect to cotton fibre purity, and this rise in standards has had an impact on cotton cropping, harvesting and ginning conditions.

Economic and qualitative impacts



Seed-coat debris on cotton yarn. © M. Krifa

Spinning machines have become more sophisticated and faster, which has made them more vulnerable to the presence of lint impurities. Cotton fibre contamination, regardless of the origin, is thus an economic impediment for the textile industry.

Manufacturers strive to reduce this contamination by intensifying cleaning operations during ginning (increasing the number of seed-cotton and lint cleaners) and spinning (precleaning during general preparation, cleaning during spinning). Cleaning trash that can be separated from the fibres leads to a loss of material, which could be detrimental to the intrinsic technological fibre properties. Carding is not very effective for eliminating impurities such as hull fragments—this operation may even shatter the fragments, so carded lint may contain a higher number of fragments than raw lint.

Seed-coat fragments are a major source of yarn imperfections (neps, thick places) when fibres are processed into yarn and fabrics. The presence of this trash during spinning reduces the yarn yield (quantity of yarn obtained from a quantity of raw fibre or obtained per time unit) and quality. Moreover, yarn twisting helps bond the fibres, but bonding is hampered by the presence of these fragments, thus reducing the tensile strength of the yarn. Yarn tension is high during weaving and knitting operations, so the presence of seed-coat fragments can induce yarn breakage, thus causing machine shutdowns and increasing production costs.

Some fabric finishing operations such as scouring and bleaching may eliminate most seed-coat fragments. These operations enhance the visual aspect of the product but not its strength. After dying or printing, residual seed-coat fragments appear as dark spots, often surrounded by a paler area, which reduces the market value of the product.

Trashcam assessment of seed-coat fragment contamination in fibre web and yarn. © R. Frydrych

Control methods and recommendations

Initiatives to reduce seed-coat fragment contamination in cotton fibre have been focused on cotton technology and breeding. CIRAD invented Trashcam, an apparatus designed specifically for identifying, quantifying and measuring seed-coat fragments in cotton fibres. This instrument is mainly used by scientists to assess the negative effects of these fragments on yarn quality, especially its uniformity and strength. These effects are more marked when high quality fibre is involved.

This trait is genetically heritable, so breeding studies have been carried out by CIRAD, giving rise to varieties that produce cotton with low seed-coat fragmentation, in addition to excellent agricultural and technological features. Cotton breeders also use Trashcam to evaluate this criterion in their breeding programmes.

For further information

Bachelier B., Lassus S., 2000. Breeding against seed coat fragments in cotton fiber (*Gossypium hirsutum* L.) using image analysis on card web. *In* Beltwide Cotton Conferences, San Antonio, TX, USA, 3-10 January 2000. s.l., s.n., 7 p. Beltwide Cotton Conferences, 2000/01/03-10, San Antonio, USA.

Bachelier B., 1998. Contribution à l'étude de la variabilité et du déterminisme génétique de la teneur en fragments de coques de la fibre de coton. Premières applications pratiques en sélection chez *Gossypium hirsutum* L. PhD thesis in Biology and Agronomy, ENSAR, Rennes, France, 271 p.

Gourlot J.P., Frydrych R., Héquet E., Thollard F., Constantin O., Bachelier B., 1995. Seed coat fragment counting and sizing in card web. *In* Beltwide Cotton Conferences, 1995/01/04-07, San Antonio, TX, USA, Proceedings of the Beltwide Cotton Production Research Conferences, National Cotton Council, Memphis, TN, USA, 1245-1249.

Krifa M., 2001. Etude des fragments de coque de graines de coton : Détection, caractérisation, interaction avec les processus de filature et influence sur la qualité du fil. PhD thesis in Engineering Science, ENSITM, Mulhouse, France, 258 p.

Mangialardi G.J., Lalor W.F., 1990. Propensity of cotton varieties to neppiness. Transactions of the ASAE, 33 (6): 1748-1758.

Pearson N.L., 1939. Relation of the structure of the chalazal portion of the cotton seed coat to rupture during ginning. Journal of Agricultural Research 58 (11): 865-873.

Partners

ENSITM, Ecole nationale supérieure des industries textiles de Mulhouse, France

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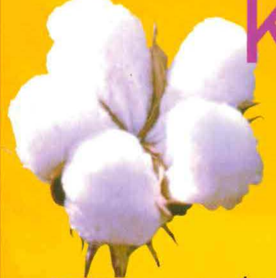
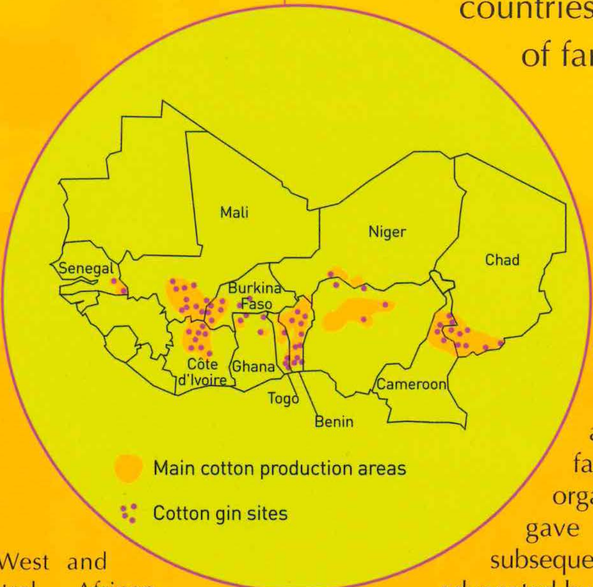


Key role of farmers' organizations

Farmers' participation in national agricultural policymaking is a key challenge for the reorganization of cotton subsectors in many African countries. Cotton producers have been handicapped by the drop in world prices and many national cotton companies are currently being privatized. CIRAD is thus working with institutions in several African countries and is actively promoting the professionalization of farmers' organization leaders.



In West and Central African countries, cotton production is currently above a million tonnes of fibre, i.e. 14% of the total world trade volume in 2004, whereas it was only 4% in 1980! Cotton thus accounts for up to 40% of the export earnings of these countries. Ten million people are living on income from this competitive crop—one of the few African success stories…

Advent of farmers' organizations

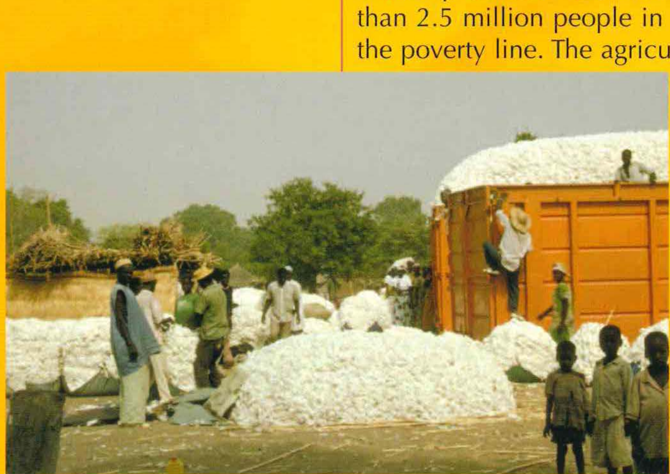
In West and Central African countries of the "franc area", cotton development was based on the same model until the 1990s, i.e. a semipublic cotton company managing the industry, with village farmers' organizations linked to the company. The heads of these organizations thus benefited from literacy and training initiatives, which gave rise to trained literate farmer leaders. The cotton sector was subsequently affected by structural adjustment policies and privatization, often advocated by the World Bank. Cotton farmers then began forming organizations to safeguard their interests.

The Malian situation

In Mali, the drop in world cotton prices combined with the deficit of CMDT, the Malian textile development company, sent shock waves through the industry and signalled the end of the system of remunerative prices and guarantees for producers. In 2004, the government bolstered the industry with the help of donors. In 2005, the seed cotton buying price dropped by 20% relative to prices the previous year, which had a serious impact on farming families and on the Malian economy.

Cotton producers' cash income is now plummeting—175 000 families are affected, or more than 2.5 million people in a region where almost 80% of rural inhabitants are living under the poverty line. The agricultural sector is the mainstay of the Malian economy, so this crisis will have an unprecedented impact, i.e. a 2-4 point drop in the GDP and a reduction in farm household consumption, with a concomitant reduction in other trade and service activities.

In this harsh setting, it is vital to create a farmer-managed support mechanism to freeze production prices and boost competitiveness. The longer term challenge is also to enhance farmers' status in the new privatized industry and in coordination bodies, e.g. in the joint-trade organization currently being developed.



Loading harvested cotton.
© P. Dugué

Farmers' initiatives...

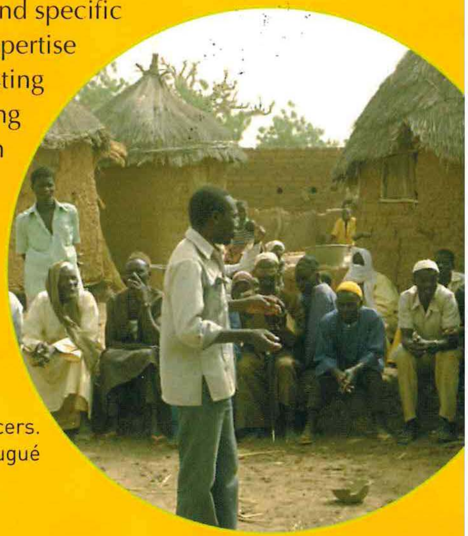
In Burkina Faso, the cooperative union has common shares in the three cotton companies located in the cotton-growing areas (SOFITEX, FASOCOTON, SOCOMA), so farmers have direct access to information and are involved in decision making.

In Mali, farmers have formed unions. The first movement occurred in 1992, with a strike affecting deliveries of cotton to CMDT, which had a seed cotton purchasing monopoly. Farmers also went on strike in 2000 and refused to sow the cotton crop, resulting in a spectacular 50% drop in production. The unions are now partially associated with the industry management and handle certain economic activities.

The voice of African farmers in international bodies

In September 2003, four African countries protested the subsidization of cotton producers in several countries (especially USA and EU states) which has distorted world prices. Benin, Burkina Faso, Mali and Chad put forward a proposal during the 5th WTO Ministerial Conference at Cancún calling for the subsidies to be eliminated. This African initiative drew worldwide attention to the cotton issue and more generally to the conditions of international integration of poor countries into liberalized markets. For the first time, international trade negotiations were tripped up by a request from a developing country, and this demand was legitimized by most other countries. However, no precise response to the African cotton issue was provided at the 6th WTO Ministerial Conference at Hong Kong, in December 2005, despite the progress made at Geneva in November 2004 with the creation of the WTO Cotton Sub-Committee.

Beyond these events, the key breakthrough is the progressive participation of African cotton producers in national and international discussions. The African Cotton Producers' Association (APROCA) was thus founded. These producers are now quickly gaining experience with respect to world cotton market operations and specific features of cotton subsectors. CIRAD—through research, expertise and training activities—is involved with its partners in assisting these farmers' organizations in developing their own strong arguments to put forward within coordination and negotiation bodies.



Technical discussions among cotton producers.
© P. Dugué

Partners

IER, Institut d'économie rurale, Mali

ROPPA, Réseau des organisations paysannes et de producteurs agricoles d'Afrique de l'Ouest, Burkina Faso

For further information

Bosc P.M., Berthomé J., Losch B., Mercoiret M.R., 2002. Le grand saut des organisations de producteurs agricoles africaines : de la protection sous tutelle à la mondialisation. Revue internationale d'économie sociale 285: 47-62.

Nubukpo K.K., Keita M.S., 2005. Réforme du mécanisme de fixation du prix d'achat du coton au producteur malien et conséquences dans un contexte de chute des cours mondiaux. *In* Hazard E. (ed.), Négociations commerciales internationales et réduction de la pauvreté. Le livre blanc sur le coton. Enda Editions, Dakar, pp. 117-131.

Pesche D., Nubukpo K., 2004. L'Afrique du coton à Cancun : les acteurs d'une négociation. Politique Africaine 95: 158-168.

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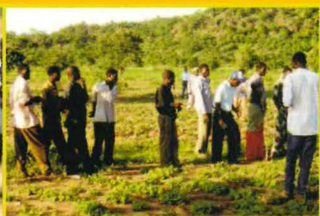
Family farming advice in West African cotton-growing areas

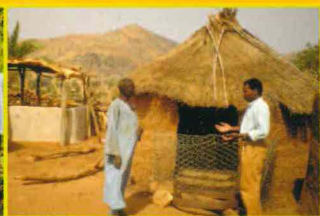
The development of cotton production in Western and Central Africa began in the 1960s. Most farmers have acquired considerable technical skills concerning this crop, especially with respect to the use of animal draught, herbicides, weed and pest control. Current initiatives are geared towards improving farming system adaptability by providing better advice on technical and economic issues. CIRAD and partners are conducting development-oriented research to come up with family farming advisory systems that could facilitate farmers' adaptation to a diverse range of situations.

A progressive approach

Family farming advice is aimed at developing farmers' decision-making capacities and responsibilities. Through a self-analysis approach, extension officers encourage discussion, initiatives and forecasts on both technical and economic aspects of overall farm operations.

Year 1 — From training to management basics;
Year 2 — ...to taking technical-economic indicators into account;
Year 3 — ...to analyse and provide farm advice.





From group leadership → to individual advice

Collective discussion at Mafa Kilda, Cameroon. © PRASAC

A field visit, Cameroon. © PRASAC

Extension officer and cotton farmer, Cameroon. © P. Dugué

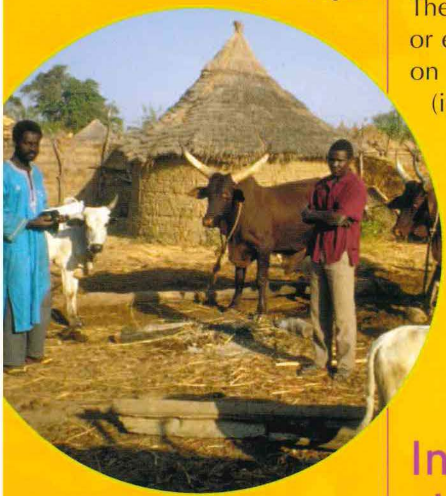
Farm management advice—the initial strategy

In cotton-growing regions of Mali and Burkina Faso, CIRAD and partners first developed a farm management advice strategy whereby extension officers trained farmers on the use of management tools. This farm management advice was designed for literate farmers who were instructed on keeping a management log book, which enabled them to calculate and analyse gross margins per crop (or per livestock unit) and manage the farm finances. This operational method worked if the extension officers were paid through a development project, but it was expensive since the groups handled by each officer were limited to around 20 farmers. Finally, some deviations were noted, e.g. extension officers were sometimes obliged to record data (normally the farm leader's task).

Farmers getting farm management advice, Cameroon. © P. Dugué

The new strategy—farmer training oriented groups

Farm advisor talking to a farmer on draught oxen care, Cameroon. © P. Dugué



Nowadays, family farming advice is focused more on promoting farming principles than on using standard management tools. Methodological manuals are available for extension officers. A log book is still used to record data, but the emphasis is on analysing the different steps of the decision process so that illiterate farmers will also benefit from the farming advice. The log book is used when the participants' decisions have to be based on accurate technical or economic indicators. This initiation to economic management is accompanied by advice on new technical practices used by farmers or other techniques that could fulfil their needs (innovations developed by scientists or farmers from other regions).

This advisory work on farmers' strategies, technical options and management tools involves groups of 10-15 farmers. The extension officer thus becomes a trainer whose task is to initiate discussions and in turn supervise dynamic collective and individual initiatives, e.g. experiments carried out by farmers or a village seed-production organization.

Information exchange via farmers' socioprofessional networks

In western Burkina Faso, recent studies by CIRAD revealed that technical and economic information spread via socioprofessional networks based on key farmers. Village cotton producers' group leaders could be effective agents for transmitting this information. However, cotton extension systems currently depend on extension officers who just oversee a few farms. This system is now hard to finance because of the cotton crisis and the lack of funds available to pay extension officers. CIRAD and partners have initiated research programs in two directions:

- promoting greater farmer autonomy by focusing on training rather than on providing individual advice;
- promoting local information exchange dynamics through resource farmers supported by farmers' organizations so as to reduce extension officer interventions.

Partners

Burkina Faso: SOFITEX, Société burkinabé des fibres textiles • UNPCB, Union nationale des producteurs de coton • INERA, Institut national de l'environnement et des recherches agricoles

Cameroon: IRAD, Institut de recherche agricole pour le développement • SODECOTON, Société de développement du coton

Mali: PASE, Programme d'amélioration des systèmes d'exploitation en zone cotonnière

Chad: PRASAC, Pôle de recherche appliquée au développement des savanes d'Afrique centrale

For further information

Djamen Nana P., Djonnéwa A., Havard M., Legile A., 2003. Former et conseiller les agriculteurs du Nord-Cameroun pour renforcer leurs capacités de prise de décision. Cahiers Agricultures 12: 241-245.

Faure G., Dugué P., Beauval V., 2004. Conseil à l'exploitation familiale. Expériences en Afrique de l'Ouest et du Centre. Guide Pratique. Paris, GRET; Montpellier, CIRAD, 127 p.

Foy-Sauvage L., Rebuffel P., 2002. Etudes des processus d'échanges d'information et d'apprentissage en milieu rural sahélien pour l'accompagnement des dynamiques d'autodéveloppement. *In* Actes du colloque Savanes Africaines : des espaces en mutation, des acteurs face à de nouveaux défis. Garoua, 27–31 May 2002, PRASAC, CIRAD. [CD-ROM] ISBN CIRAD 2-87614-580-4.

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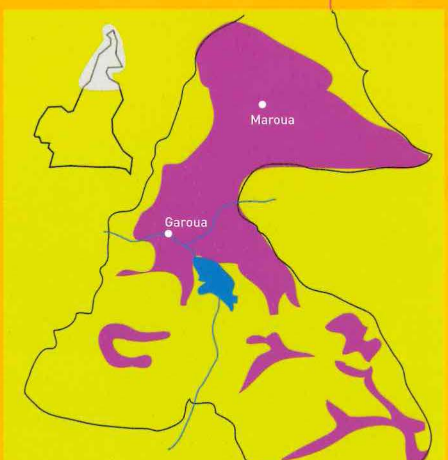
Direct seeding mulch-based cotton cropping systems in Cameroon

In the cotton-growing region of northern Cameroon, CIRAD, IRAD and SODECOTON are conducting research, in both the station and on farms, on direct seeding mulch-based cropping systems (DMC). The focus is on specific cropping techniques and on merging these cropping systems with traditional land, farm and livestock management practices.

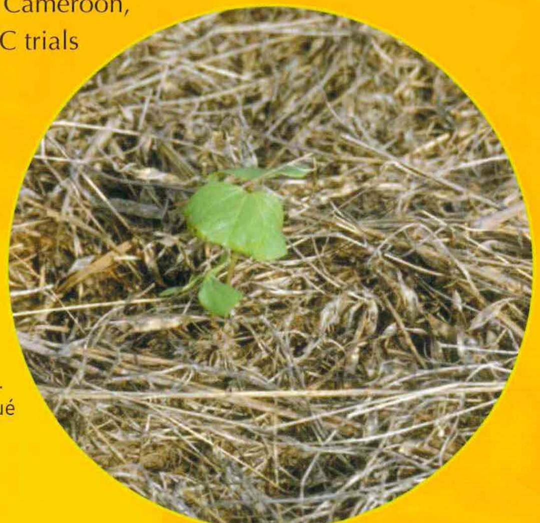
DMC features

Direct seeding mulch-based cropping systems are unique as they do not require tillage, the soil is permanently protected with mulch or a special live plant cover, and the main crop is grown in rotation with an improvement crop. These cropping systems are designed to achieve high sustainable crop yields, preserve and enhance soil fertility by reducing erosion and generating organic matter and, finally, alleviate heavy labour.

Brazil is currently the most advanced country with respect to DMC adoption, with over 20 million ha under such systems. In Cameroon, CIRAD and partners initiated the first DMC trials in 2001.



Cotton-growing region of northern Cameroon.



Cotton plant emerging from mulch. © P. Dugué

Better yields with a cotton-cereal crop rotation

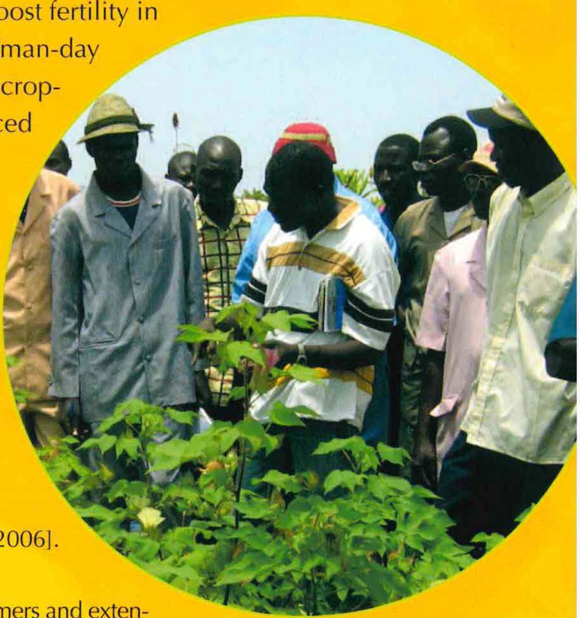
Cotton-cereal crop rotations are common in northern Cameroon. The first DMC were based on this rotation. In the first year, the cereal (sorghum, maize or millet) is intercropped with a cover crop, e.g. *Brachiaria ruziziensis, Mucuna pruriens, Dolichos lablab, Crotalaria retusa* or *Vigna unguiculata*. The generated biomass is left in the field or partially grazed by livestock and serves as mulch for the subsequent cotton crop.

Manbang village. 2003. A DMC is shown on the left—biomass production is greater and *Brachiaria ruzisiensis* inhibits witchweed (*Striga* sp.) growth. On the right, the sole sorghum crop is almost completely overrun by witchweed (pink-blossomed parasitic plant).
© K. Naudin

The same plot in 2004. On the left, cotton was direct seeded on sorghum + *Brachiaria ruzisiensis* mulch. On the right, cotton was sown after tillage. The DMC cotton crop is at a more advanced growth stage than that grown in the tilled area since it was sown 15 days earlier (as no tillage was required) and since soil moisture was higher under the mulch.
© K. Naudin

EIn 2004, in the northernmost part of Cameroon, where drought is most severe, DMC cotton fields had a mean seed cotton yield of 1.8 t/ha, while conventionally cropped cotton fields yielded 1.5 t/ha. This yield gain was mostly due to enhanced rainwater infiltration and more efficient water use by the crop.

These techniques reduce labour time. Direct seeding mulch-based cotton cropping systems require less labour and cultivation than conventional cotton cropping systems, i.e. no tillage or ridging, no weeding if there is an adequate mulch layer. The overall results are better under cotton DMC, even when herbicide spot treatments are necessary because the mulch layer is not sufficient and when urea has to be applied to boost fertility in the first 2-3 years, e.g. labour productivity is €3.5/man-day as compared to €2.3 under a conventional cotton cropping system. Soil structure and fertility are enhanced in addition to the higher crop yields.



Farmers being trained on cotton DMC techniques.
© K. Naudin

Partners

Cameroon: IRAD, Institut de recherche agronomique pour le développement • SODECOTON, Société de développement du coton

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For further information

CIRAD Agroecology Network site, 2005. [On line] [01-01-2006]. http://agroecologie.cirad.fr

IIRR, ACT, 2005. Conservation Agriculture: A manual for farmers and extension workers in Africa. Published by the International Institute of Rural Reconstruction and the African Conservation Tillage Network. Available from IIRR-Africa, P.O. Box 66873 Westlands, Nairobi, Kenya, 269 pp., ISBN 9966 9705 9 2(Pb). [On line] [01-01-2006] http://www.iirr.org http://www.act.org.zw
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Farmers' strategies in Central African cotton-growing areas

In Central Africa, cotton development is tightly linked with the role of governments in providing technical support, credit for farmers and ensuring that farmers' harvested produce will be purchased at a fixed price. These government interventions began being questioned in the 1980s, however, because of the financial deficits, just at the time of the world cotton market crisis. Since then, cotton subsectors have been restructured, governments have withdrawn from their commitments, national cotton companies are being privatized and farmers are forming an increasing number of professional organizations. CIRAD and PRASAC, its Central African research and development partner, thus conducted an analysis of farmers' adaptation strategies within this setting.

Central African savannas suitable for cotton cropping.

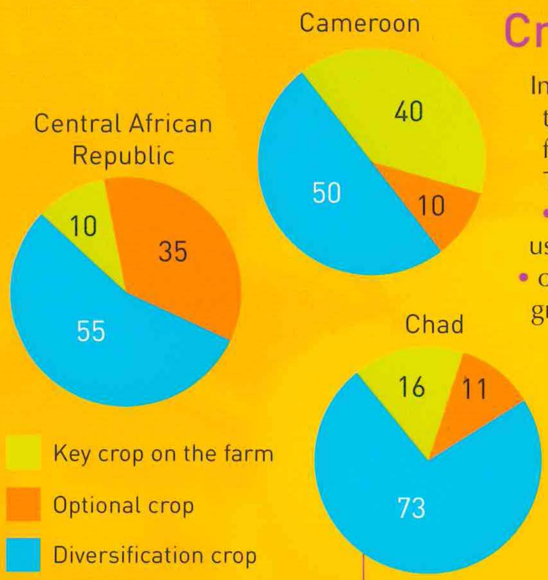
Cotton cropping from the farmer's standpoint

According to cotton producers, cotton cropping has developed through three main phases—cropping by colonial settlers prior to independence, cropping by traditional or administrative authorities after independence, and cropping by individual farmers as of the 1980s. The great cotton crisis began around 1985 when prices plummeted, followed by a roller-coaster type price pattern. Cotton is thus now considered as a risky crop. The drop in seed cotton purchase prices, sometimes with a concomitant rise in input prices, were the main features of the cotton crisis that affected farmers.

The current status of cotton in Central African production systems depends on the region and the type of farm considered. Cotton could potentially account for over a half of the farm income, despite the fact that yields of this crop are low and it is grown on less than a third of the total cropland. This contribution is very low in the Central African Republic, however, because farmers' activities are very diversified. In all cases, income from cotton enables farmers to invest in draught animals, livestock, homes and land, to pay back debts and even buy cereals, which is currently taking place on farms affected by food shortages in Cameroon and Chad.

Status of cotton on farms in Cameroon, Chad and the Central African Republic

Farm characteristics	Cameroon	Central Africa Republic	Chad
N° of people	6 (incl. 3 workers)	6 (incl. 2.9 workers)	6.1 (incl. 3.3 workers)
Total cropping area (ha)	2.2	2.2	2.8
Area under cotton (% of total cropping area)	33	25	21
Seed cotton yield (kg/ha)	1 000	630	660
Total farm income (FCFA)	270 000	250 000	220 000
Income from cotton (% of total farm income)	60	15	52



Three crisis adaptation strategies of cotton farmers.

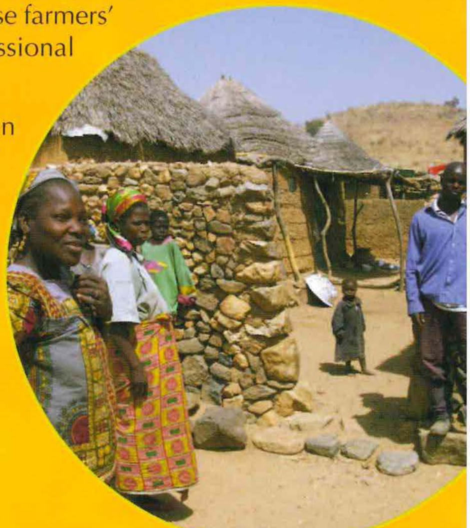
Crisis adaptation strategies

In all cases, the head of the farm decides on whether or not to grow cotton according to his/her own interest and pending opportunities. Under the current crisis, farmers first react individually by adjusting their activities to offset the market impact. There are three trends:

- farmers who consider cotton as the key crop in their production system. They usually manage large farms with many workers;
- opportunistic farmers whose strategy is not just focused on cotton cropping. They grow cotton when prices rise but not when they decline;
- farmers who consider cotton as a diversification crop. These farmers operate diversified farms and are the most numerous. They may reduce the cotton crop to focus on other activities, but still keep it for the fringe benefits.

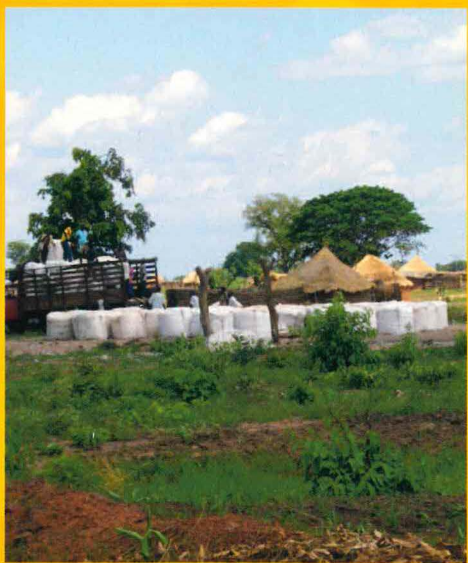
From a collective standpoint, farmers benefit from mutual group solidarity in their adaptation initiatives, thus minimizing social costs associated with individual strategies. Farmers' organizations are formed to share resources among members, to coordinate activities and to have more clout when dealing with other operators in the subsector. These farmers' organizations are now beginning to closely resemble professional organizations.

In response to these different strategies, PRASAC, in partnership with CIRAD, development agencies and farmers' organizations, assessed various counselling schemes designed to help individual farmers and farmers' organizations adapt to changing patterns within the subsector.



A family of cotton farmers in northern Cameroon.
© J.-Y. Jamin

Collection of harvested cotton at Léré, Chad.
© J.-Y. Jamin



Partners

Chad: ITRAD, Institut tchadien de recherche agronomique pour le développement • PRASAC, Pôle de recherche appliquée au développement des savanes d'Afrique Centrale

Cameroon: IRAD, Institut de recherche agricole pour le développement

Central African Republic: ICRA, Institut centrafricain de recherche agricole

For further information

Mbétid-Bessane E., Havard M., Djonnéwa A., Djondang K., Leroy J., 2002. Stratégies des agriculteurs des savanes d'Afrique centrale face à la restructuration de la filière coton. *In* Jamin J.Y., Seiny Boukar L. (scientific editors). Savanes africaines : des espaces en mutation, des acteurs face à de nouveaux défis. Conference proceedings, Garoua, 27–31 May 2002, PRASAC, CIRAD. [CD-ROM] ISBN CIRAD 2-87614-580-4.

Mbétid-Bessane E., 2002. Gestion des exploitations agricoles dans le processus de libéralisation de la filière cotonnière en Centrafrique. PhD thesis in Economy, Institut national polytechnique de Toulouse, France, 317 p.

Kossoumna Liba'a N., Havard M., 2006. Mutations de la filière cotonnière dans les provinces septentrionales du Cameroun. Perception et stratégies paysannes. *Cahiers de Géographie du Québec*, Vol. 50, No.°139: 65-82.

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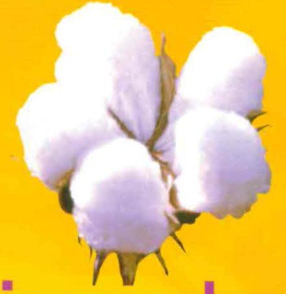


Fertilization of cotton crops in sub-Saharan Africa

In West and Central Africa, cotton farmers buy most of their chemical fertilizers from cotton companies—directly for cotton crop fertilizers and under payment guarantees for food crop fertilizers. These companies provide credit for input supplies and farmers pay them back when the cotton is first marketed. Cotton cropping has an economic role via the cash income this activity generates, but it is also essential in maintaining soil fertility through mineral inputs by chemical fertilizer applications. CIRAD is studying fertilization practices under crop rotation systems to assess the short-term economic impacts and longer term effects on soil fertility.

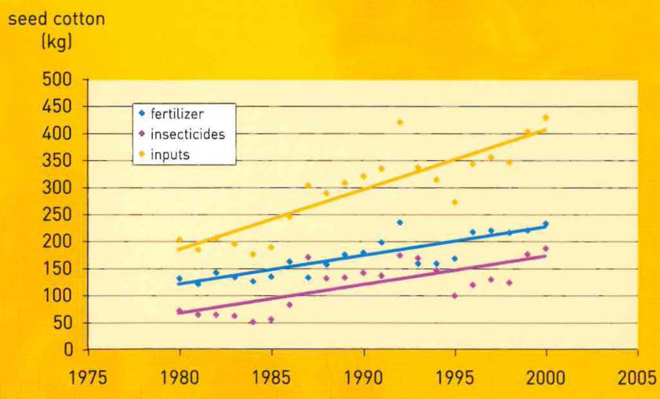
High mineral deficiency

There can be a shortage of some minerals (K^+, Ca^{++}, Mg^{++}) in soils under cotton-cereal rotation systems. Organic and chemical fertilizer applications cannot offset mineral losses caused by the export of harvested crops and crop residue.

Example of the potassium mineral balance of a typical 3-year crop rotation (sorghum-cotton-sorghum) in Mali.

Crop and obtained yield (kg/ha seed or seed cotton)	Fertilization (K_2O, kg/ha)		Exportation (K_2O, kg/ha)		Potassium balance (kg/ha)
	fertilizer	manure	harvest	residue	
Sorghum 1 000 kg	12	17	11	16	+ 2
Cotton 1 300 kg	4	17	5	52	– 36
Sorghum 1 000 kg	4	17	5	52	– 36
Total: 3-year deficit balance					– 70

Since the 1980s, the price of chemical fertilizers has increased substantially whereas the purchase price for seed cotton from producers has markedly dropped—in 2000, producers had to sell twice as much cotton to pay for their inputs than in 1980. The quantity of chemical fertilizers applied by farmers in their crop fields has consequently decreased. This means that the crops do not grow as well, i.e. lower yields, and lower amount of crop residue recycled in the soil (roots, stems, straw, etc.), with a concomitant worsening of the soil mineral deficiency in these fields.



Variations (in seed cotton equivalents) in costs concerning cotton cropping inputs (fertilizers, pesticides, sum of these inputs) in Burkina Faso.

Chemical fertility of tropical soils

Maintaining the organic fertility of tropical soils is a key challenge for the future of cotton-growing areas in sub-Saharan Africa, for three reasons. First, soil organic matter mineralization is the main source of essential nutrients for crops. Secondly, in addition to clay contents, soil organic matter accounts for a major share of the cation exchange capacity of soils, which is an essential transitional phase for some mineral elements (potassium, calcium, magnesium) prior to their assimilation by crops. Thirdly, the intense bioactivity in soils, which is responsible for soil organic matter mineralization, makes the chemical soil fertility component highly volatile.

Nutrient deficiency symptoms in long-standing cotton fields

Potassium deficiency symptom on a cotton plant.

Chronic soil mineral deficits can lead to the depletion of soil reserves of some minerals, especially potassium and magnesium. Crops may then show visible signs of nutrient deficiency disorders—magnesium and potassium deficiency symptoms are very common in regions with a long history of cotton growing. In these areas, the formula of compound fertilizers commonly used in cotton crop fields (14 N - 23 P - 14 K - 5 S - 1 B) should thus be modified by reducing the phosphorus concentration, increasing that of potassium and adding magnesium.

CIRAD, in partnership with national agricultural research systems, puts forward recommendations to cotton companies with respect to establishing conditions for chemical fertilizer supply tender requests. CIRAD experts also advise farmers on adapting mineral manure applications in cotton crop fields according to the cropping history of the field.

IFDC's MIR project, based on recommendations put forward at the Cotton Conference of West and Central Africa (Cotonou, 2005), is under way in four countries (Benin, Togo, Burkina Faso and Mali), in collaboration with the West and Central African Council for Agricultural Research and Development (WECARD), farmers' organizations and fertilizer manufacturers. The aim of this project is to conduct tests in Benin, Togo and Burkina Faso to assess results previously obtained in Mali, while also tailoring fertilizer formulas to overcome soil mineral deficiencies noted in this part of Africa.

Magnesium deficiency symptom on a cotton plant.

Frequency (%) of deficiency symptoms observed in cotton-growing regions of Mali in 2004 relative to the number of plots surveyed (104 plots in 12 villages).

Region	Nitrogen	Phosphorus	Potassium	Magnesium
Fana	12	4	59	57
Koutiala	100	0	97	84
Sikasso	25	0	52	50
Bougouni	46	0	71	0
Kita	10	0	91	58

Partners

Africa: INRAB, Institut national des recherches agricoles du Bénin, Benin • INERA, Institut national de l'environnement et des recherches agricoles, Burkina Faso • IER, Institut d'économie rurale, Mali • ITRA, Institut togolais de recherche agronomique, Togo

IFDC, International Center for Soil Fertility and Agricultural Development (Benin, Burkina Faso, Mali, Togo)

For further information

Braud M., 1981. Intérêt du cotonnier, support de tests biologiques pour contrôler l'évolution de la fertilité d'un sol. Coton et Fibres Tropicales, 36 (4): 305-312.

Crétenet M., Dureau D., Troré B., Ballo D., 1994. Fertilité et fertilisation dans la région sud du Mali : du diagnostic au pronostic. Agriculture et Développement 2: 4-13.

Hodges S.C., 1992. Nutrient deficiency disorders. *In* R.J. Hillocks (ed.) Cotton diseases. CAB International, Wallingford, UK, pp. 355-403.

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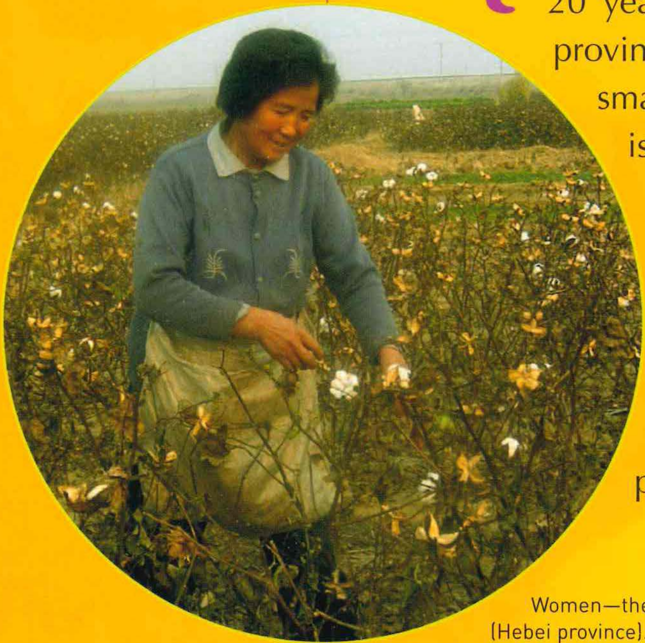
Cotton in China—a giant with intensive sustainable smallholdings run by women

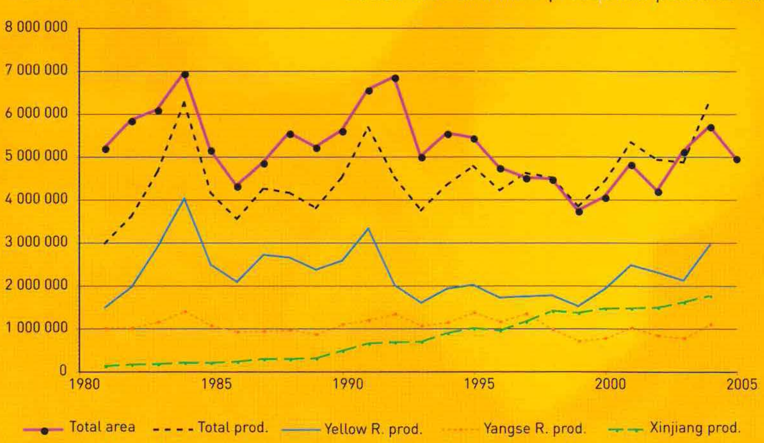
China has been the world's top cotton producer for more than 20 years. CIRAD conducted surveys in Hebei and Jiangsu provinces, in collaboration with its Chinese partners, to assess smallholder cotton production patterns. Structurally, China is still a cotton importer. The adoption of genetically modified cotton varieties has not altered this situation because of the tiny size of farms. Chinese family agriculture is highly resilient due to diversification of farm family income sources, and labour reorganization, with women taking on a key role—this flexible setting should enable China to maintain its top world cotton production ranking.



Women—the main full-time farmers (Hebei province).
© M. Fok

Cotton production in three expansive areas

Cotton area and fibre production patterns since 1981.



In China, cotton was grown on an area of almost 5 million ha in 2005. Crop yields are amongst the highest in the world, i.e. around 3 500 kg/ha of seed cotton.

The Yellow River Valley is the traditional cotton-growing area, and it is also where genetically modified varieties are the most widely cropped. The autonomous region of Xinjiang, a dry area in western China, currently accounts for more than a third of the national cotton production. Further south, in the Yangtze River Valley, cotton is hampered by having to be integrated in systems with two to three crop cycles.

Farmers using their own vehicles to deliver harvested cotton to a buying centre (Hebei province). © M. Fok

Intensive technically-advanced cotton production

High sustainable crop yields are achieved through supplementary irrigation, plastic mulching and application of high dosages of inputs (fertilizers, pesticides, growth regulators). There is also high labour investment on garden-sized plots, for transplanting, weeding and topping plants after the fruiting stage.

The government has long been subsidizing cotton crop intensification in various ways with the aim of reducing input expenditures. Substantial decentralized research is also being supported, which has given rise to many original and widely adopted innovations (transplanting techniques; cotton growth regulation systems; genetically modified varieties containing two complementary genes, including one Bt gene; and hybrid varieties). The cotton industry was liberalized after the mid-1990s and crop intensification strategies are still being implemented despite the high cost to farmers.

Home of a farmer involved in input distribution (Jiangsu province). © M. Fok

Tiny part-time farms managed by women

Chinese farms are generally a few thousand square metres in size (0.3-0.6 ha). An average farming family consists of three to four members, but only one to two of them actually work in the crop fields. Women seldom have a salaried job outside of the family farm, so it could be stated that farming is now generally managed by women and elderly people.

CIRAD's surveys conducted in Hebei and Jiangsu provinces revealed that farming is no longer the main income source of farming families. Non-agricultural income enables farmers to practice intensified cropping and to sell their farm produce when the prices are most favourable. This factor enhances their resilience. The gap is widening with urban dwellers, but farmers' living standards are improving, as many households are now equipped with various appliances (TV, washing machine, microwave oven, residential phones and cell phones).

Partners

China: HEBAU, Hebei Agricultural University, Hebei • RIIC, Research Institute of Industrial Crops, Jiangsu Academy of Agricultural Sciences, Nanjing

For further information

Fok A.C.M., Liang W., Wang G., Wu Y., 2005. Diffusion du coton génétiquement modifié en Chine : leçons sur les facteurs et limites d'un succès, Economie Rurale, 285: 5-32.

Fok A.C.M., Liang W., Wang Z. L., Wu Y., 2004. Differentiated management of GM diffusion in China: Further hampering the self-sufficiency in cereal production? *In* Développement durable et globalisation dans l'agroalimentaire : Colloque international AIEA2 et Ateliers de la SCAE, Université Laval, Quebec, 23-24 August 2004. AIEA2, Montpellier, France; SCAE, Ottawa, Canada, pp. 417-427.

Liang W., Fok A.C.M., Wang G., Wu Y., 2004. A part-time and female-managed agriculture: an orientation not sufficient to catch up the income gap in China. *In* Colloque SFER Les mutations de la famille agricole, conséquences pour les politiques publiques, 22-23 April 2004. SFER, Paris, France, 17 p.

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Cotton technology—Quality at every stage

Cotton has been utilized by humans for over 8 000 years and was the first textile crop. Comprehensive knowledge on the intrinsic properties of cotton fibre has secured the success of today's cotton lint and yarn trade. The CIRAD Cotton Technology Laboratory is conducting research on cotton product (seed cotton, cottonseed and fibre) quality criteria, and is investigating all possible ways of effectively promoting this quality, through classification and standardization systems and innovative uses or devices.

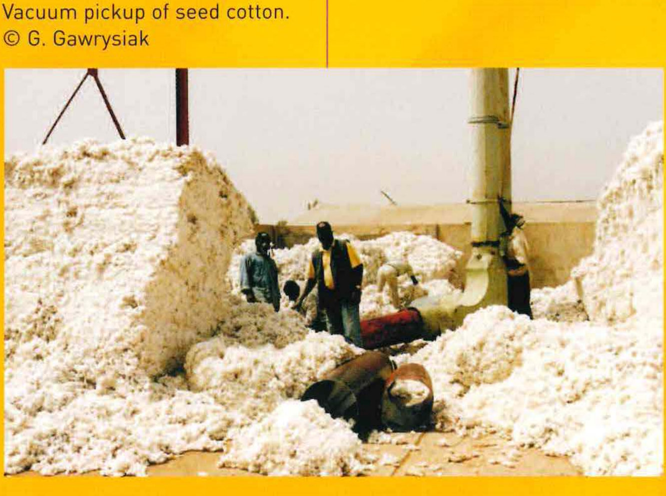
Cottonseed technology

Cottonseeds have a high cellulose, protein and lipid content and many dietary and industrial uses. The main coproducts are cellulose derivatives, edible oil for human consumption and seedcake for livestock feed. CIRAD is focusing research on proteins extracted from crushed cottonseed to assess their food and film-forming properties.

The CIRAD Cotton Technology Laboratory

The CIRAD Cotton Technology Laboratory studies relationships between the technological traits of cotton fibre and yarn, the impact of air conditioned rooms, the effects of trash, the features of devices from different manufacturers, the behaviour of cotton blends, cotton-silk blends, etc. The laboratory provides support for agronomic and genetic studies under way in developing countries to choose varieties on the basis of final lint quality and market demand. It also assists molecular biologists in locating genetic markers for fibre quality. In conjunction with its high involvement in dealing with cotton lint contamination, the laboratory also files patents, develops devices and markets them after the technology is transferred to local companies. The laboratory is promoting cotton quality, especially by developing and updating measurement methods and operating procedures. It offers training courses, such as that held in Benin in 2005 to benefit the eight cotton producing countries of the West African Economic and Monetary Union. The laboratory regularly conducts laboratory appraisals and audits worldwide.

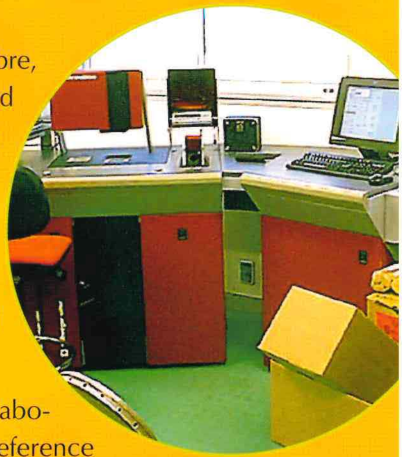
Ginning mill, Cameroon.
Vacuum pickup of seed cotton.
© G. Gawrysiak



Ginning

Seed cotton ginning involves separating fibre from cottonseed using saw or roll gins. The CIRAD Cotton Technology Laboratory has gained solid experience in maintaining fibre quality during and after ginning, as well as calibrating and operating small-scale gins for the purpose of assessing industrial units and processing tiny quantities of seed cotton, particularly for breeders to select new varieties.

Automated device for measuring fibre characteristics. © CIRAD



Fibre characteristics

It is essential to gain insight into the technological traits of cotton fibre, including length, length uniformity, strength, colour, fineness and maturity. This data is used to guarantee that the product meets the high commercial trade standards. These features must be evaluated under specific conditions because some may be altered by temperature and humidity. Fibre analyses are thus performed with instruments set up in air-conditioned rooms in compliance with international standards. Reference standards are also required to calibrate the analytical instruments.

The CIRAD Cotton Technology Laboratory is one of the six laboratories in the world involved in a programme to assess cotton reference standards used to calibrate all measurement devices worldwide that are marketed by USDA in the United States.

Yarn processing

Micro-spinning mill in the CIRAD Cotton Technology Laboratory. © R. Frydrych

The CIRAD Cotton Technology Laboratory has a micro-spinning mill, consisting of a mini-card, a drawing frame and ring and open-end spinning machines to perform small-scale assessments of common textile processing operations. This equipment is used to test fibre performance during the spinning process. The laboratory is also equipped with special instruments for measuring yarn quality (tensile strength, elongation, evenness, defects and trash content). The test results are useful for selecting cotton varieties that meet growers' and manufacturers' needs.

For further information

Gourlot J.P., Gérardeaux E., Frydrych R., Gawrysiak G., Francalanci P., Gozé E., Dréan J.Y., Rui Liu, 2005. Sampling issues for cotton fibre quality measurements - Part 2: Impact on cotton testing instrument results. *In* Proceedings of the Beltwide Cotton Conferences, New Orleans, Louisiana, USA, 4-7 January 2005, pp. 2 328-2 341.

Gourlot J.P., Bachelier B., Gawrysiak G., Frydrych R., 2005. Elaboration, préservation et caractérisation de la qualité des fibres de coton. Volume 1: compilation of presented papers. Volume 2: appendix to the compilation of presented papers. Regional training workshop within the framework of the WAEMU Quality Programme funded by EU, organized by UNIDO, Parakou, Benin, 13-18 May 2005, 304 p. + appendices.

Lacape J.M., Nguyen T.B., Courtois B., Belot J.L., Giband M., Gourlot J.P., Gawrysiak G., Roques S., Hau B., 2005, QTL analysis of cotton fiber quality using multiple *Gossypium hirsutum Gossypium barbadense* backcross generations, Crop Science 45: 123.

Partners

West and Central Africa: IRAD, Institut de recherche agricole pour le développement; SODECOTON, Société de développement du coton, Cameroon • SONAPRA, Société nationale pour la promotion agricole; PARCOB, Projet d'appui à la recherche coton du Bénin, Benin • SOTOCO, Société togolaise du coton; IRCT, Institut de recherche coton du Togo, Togo • CNRA, Centre national de la recherche agronomique, Côte d'Ivoire • SOFITEX, Société des fibres textiles, Burkina Faso • SODEFITEX, Société de développement et des fibres textiles, Senegal • COTONCHAD, Société cotonnière du Tchad, Chad

South America: COODETEC; COAGEL; UNICOTTON, Brazil • IAN, Instituto agricol nacionale; INTN, Instituto Nacional de Tecnologia y Normalizacion, Paraguay

USA: USDA, United States Department for Agriculture • ITC, International Textile Center, Texas • Cotton Incorporated • CFC, Common Fund for Commodities

Europe: ENSITM, Ecole nationale supérieure des industries textiles de Mulhouse; UHA, Université de Haute Alsace; Groupe Dagris and subsidiaries (SOSEA, COPACO); AFCOT, Association française cotonnière; COTIMES; SYDEL, France • Bremer Institut, Germany • Uster Zellweger; Dunavant Sa; Reinhart Sa, Switzerland

Madagascar: COTONA company

Vietnam: Central For Cotton Fiber Testing and Seed Technology

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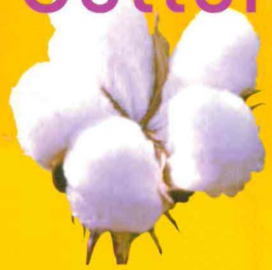
Cottonseed proteins—multifunctional polymers



Cottonseed kernels can provide a high quality dietary source of protein. CIRAD has carried out major research in this field. Proteins extracted from the kernel may also be processed into biodegradable materials to replace petroleum-based plastics. CIRAD aims to gain insight into the film-forming and adhesive properties of these proteins and develop innovative industrial manufacturing processes using known techniques.

Cottonseed structure

Whole cottonseeds consist of a kernel (60% of its weight) and a cellulose shell (40%). The seed contains 20-30% proteins and 20-30% oil, depending on the cotton variety. Seeds that are not set aside for planting are generally ground to extract edible oil and high-protein seedcake to serve as cattle feed.

Cottonseed with linters. © J. Lecomte

Cottonseed proteins for consumption

Cotton plants naturally contain gossypol, a polyphenol that is toxic to humans and monogastric animals. This compound cannot be completely removed during industrial or small-scale oil extraction processes—cotton proteins are thus fed only to polygastric livestock. Some so-called 'glandless' cotton varieties do not contain gossypol, so the derivative protein products can be consumed by humans and all animals.

Whole cottonseed. © J. Lecomte

Kernel. © J. Lecomte

Shell. © J. Lecomte

Research conducted by CIRAD and African partners revealed that cotton kernels could be processed to obtain very nutritional high-protein (over 50%) flour. The protein was studied and compared to reference proteins from milk (casein) and soybean. This cotton flour can also be used in the preparation of products to feed recently weaned or malnourished infants. Further studies also showed that cotton flours without gossypol are readily accepted by African consumers in traditional dishes (sauces, nougats, cakes).

Sections of glandless (without gossypol) and glanded (normal) cottonseeds. © J. Lecomte

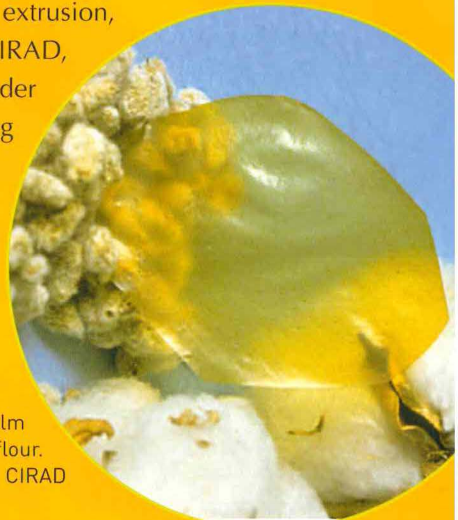
CIRAD has been conducting research on glandless cotton varieties for around 30 years, so it is fully qualified tosupport institutions planning on using deriviative products to fulfil a specific food demand. Glandless cotton can be grown as a cash or food crop, and for its fibre. However, to ensure success, all stakeholders in the subsector must implement agricultural techniques that are specifically adapted to these varieties, while also complying with the health standards.

From cottonseed proteins to biomaterials

Lettuce seeds coated with cottonseed proteins (with and without dye).
© J. Lecomte

Biodegradable materials made from natural polymers or polymers derived from plant sources could replace certain petrochemical plastics. As part of an EU project, CIRAD and partners have just demonstrated that cottonseed proteins and seedcake can be used to make flexible and rigid films, composite materials, and seed coatings.

These materials are obtained via common industrial techniques (calendering, extrusion, thermomoulding, coating). CIRAD, through ongoing research under industrial partnerships, is striving to develop products that are fully satisfactory while tailoring the properties of the materials to their end uses and assessing their shelflife under actual usage conditions.



Biodegradable film made with cotton flour.
© CIRAD

For further information

Grevellec J., Marquié C., Ferry L., Crespy A., Vialettes V., 2001. Processability of cottonseed proteins into biodegradable materials. Biomacromolecules 2 (4): 1 104-1 109.

Marquié C., Guilbert S., 2002. Formation and properties of cottonseed protein films and coatings. *In* Protein-based films and coatings, Boca Raton, UK, CRC Press, p. 139-158.

Marquié C., 1994. La graine de cotonnier *glandless* dans l'alimentation traditionnelle au Bénin. Montpellier, France, CIRAD, 36 p.

Marquié C., 1994. Les cotonniers *glandless,* source d'huile et de protéines de grande valeur pour l'alimentation humaine et animale. CIRAD-CA Final Report, EEC n° TS2-A-0245F (CD). Montpellier, France, CIRAD-CA, 102 p, two volumes, including one of abstracts.

Partners

Africa: Institut national de santé publique, laboratoire central de nutrition animale, Côte d'Ivoire • INERA, Institut national de l'environnement et des recherches agricoles; Ministère de la Santé et de l'Action sociale, Burkina Faso • Direction de la recherche coton et fibre, Benin • Les Nouvelles industries oléagineuses du Togo, Togo

Europe: University of St Andrews, UK • INCOTEC International BV, Netherlands • Ecole nationale des mines d'Alès, France; Association pour la recherche et le développement des méthodes et processus industriels, France

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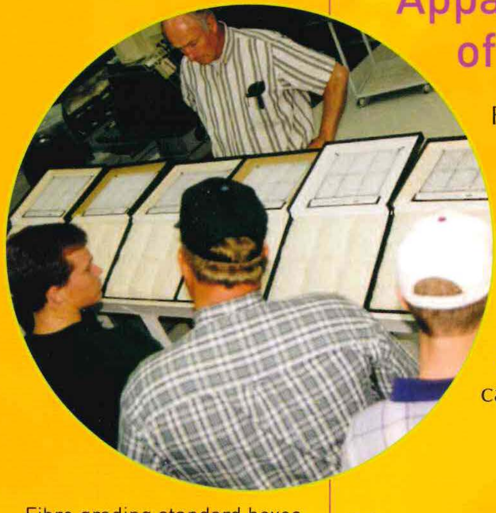
Cotton trade through private rules and bylaws

For cotton, like most agricultural export products, transactions rely on private rules and bylaws to secure contracts and settle potential disputes associated with their implementation. These systems have been operational for over 150 years and are very efficient due to the relatively high degree of equity between sellers and buyers. CIRAD conducted the first French analyses on the function of cotton private rules and bylaws and highlighted a previously unnoticed regulation adjustment that handicaps African cotton-producing countries.

Apparent simplicity of formal trade contracts



Fibre grading standard boxes.
Ginning mill, Dumas, USA.
© B. Bachelier

For a very long time, a handshake was enough to conclude a verbal agreement finalizing a transaction between a seller and buyer. Nowadays, however, formal contracts generally less than two pages long are drawn up to list the specific trade conditions, i.e. mainly the cotton quantity and quality to supply, along with the delivery date and site. The general terms and conditions of the contract are simply indicated by reference to the private rules and bylaws, which outline the terms, types of quality, two-party (buyer/seller) control conditions that apply to delivered cotton quantities and quality, or the settlement conditions in case of disputes.

Many private rules and bylaws of varied relevance

Many private rules and bylaws are in effect worldwide. In USA, different systems are found in almost every state involved in cotton production and trade. The Liverpool, Le Havre, Gent and Bremen rules apply in Europe—Europeans have not yet managed to adopt a single streamlined system as they have for coffee.

Private rules and bylaws are linked with professional cotton associations responsible for applying and safeguarding these systems. The Liverpool Rules, now called the ICA Rules and piloted by the International Cotton Association, apply to more than 60% of global cotton transactions. The Le Havre Rules—with the French Cotton Association (AFCOT) as custodian—control the sale of cotton by West and Central African cotton companies.

Limited scope to enhance the value of cotton quality criteria

Cotton quality is based on many criteria. In addition to fibre length and appearance features, many other technological characteristics can be measured (fibre uniformity, tenacity, maturity, fineness, etc.).

Private rules and bylaws integrate cotton quality enhancement by defining penalties that apply when the quality of supplied cotton is lower than that originally marketed by the seller, but there is no "compensation" in the opposite case (better quality supplied). However, all private rules and bylaws currently just include a few quality criteria with which sellers can easily comply.

Top stakeholders change the rules

Private rules and bylaws are showing signs of change worldwide in response to the increased number of rule violations and pressure to include more quality criteria. A private rule and bylaw system linked with the Shanghai stock market will soon be launched in China—the top cotton importing country. The implementation of this new system should have a more immediate impact on exporting countries.

In the West and Central African region, liberalization of the cotton industry has disrupted the cotton fibre sales market organization. CIRAD's analysis revealed that cotton is actually no longer sold to the end users (spinning mills), but transactions pass instead through an oligopoly of international traders. Some of these traders have managed to achieve vertical integration by buying out cotton companies, so now a majority of sales are simply intra-company exchanges (generally disadvantageous for the selling subsidiary). A concomitant insidious change in trade rules has also occurred that penalizes selling countries with respect to two-party quality control and reduced compliance to commitments for the removal of purchased cotton when world cotton prices are low.

Cotton gin. Ngong, Cameroon.
© G. Gawrysiak

For further information

Fok A.C.M., 2004. Les facteurs d'efficacité des Systèmes de règlements privés comme institutions de régulation des transactions marchandes. *In* Premier Colloque de l'Association française de sociologie, 24-27 February 2004, Villetaneuse, France, AFS.

Fok, A.C.M., 2005. Coton africain et marché mondial : une distorsion peut en cacher une autre plus importante. *In* Colloque Agence Universitaire de la Francophonie "Filières d'exportation de produits agricoles du Sud : réformes institutionnelles, négociations internationales et impacts socio-économiques", Bamako, Mali, 6 and 7 April 2005.

CIRAD

Cotons®-Simbad—modelling to reduce pesticide use

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Pest insect infestations damage cotton crops in all cotton-growing regions. For both economic and environmental reasons, the cotton sector is constantly striving to find alternative ways for managing these infestations with less reliance on pesticides. Sustainable management of pest insect populations is possible through well adapted agricultural practices. CIRAD and PRASAC (a research centre promoting savanna development in Central Africa) thus developed Cotons®-Simbad, a decision-support model for cotton crop protection.

Prospects

The Coton®-Simbad model is currently being validated. Once the prediction accuracy has been assessed, CIRAD will use this model to identify relevant decision criteria for pesticide treatments—decisions will be based on factors such as the crop stage, fertilization level and expected rainfall. These criteria will then be checked in the field.

Graphic image of a cotton plant obtained by Cotons®-Simbad.

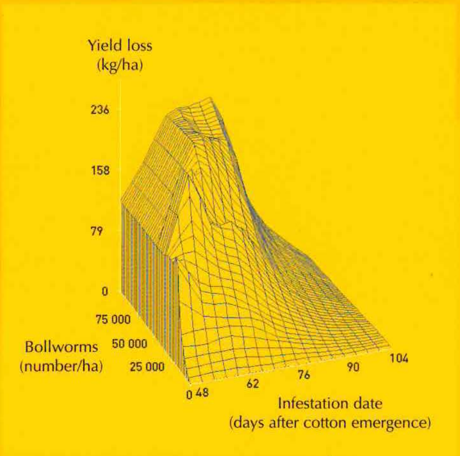
Economic threshold—a criterion to reduce pesticide use

For sustainable pest management (often called integrated pest management), pesticide treatments should only be carried out when the pest density is high enough to induce a harvest loss whose cost would exceed the potential treatment cost. The economic threshold helps farmers decide whether or not a treatment is warranted. This threshold is determined on the basis of counts of insects or symptoms they induce. Treatments are unnecessary when the field counts are lower than the threshold, but spraying may be required when it has been surpassed. By this technique, only worthwhile treatments are conducted, thus reducing the overall number of treatments as compared to calendar-based treatment strategies.

Bollworm destroying a young cotton boll.
© J.-C. Streito

Determining treatment thresholds—a complex approach

Treatment thresholds are established by correlating the number of insects in a plot with resulting crop yield losses. This correlation is, however, hard to determine with cotton. When squares and young bolls are destroyed by insects, the plant reacts by producing new bolls or by reducing 'natural' shedding of excess bolls. The efficiency of this so-called compensation phenomenon depends on the physiological status of the plant, along with other factors such as mineral nutrition and water supply. The extent of harvest loss induced by an insect population can thus vary according to the cropping conditions. Cotton cropping conditions in sub-Saharan Africa sometimes differ markedly with respect to the environmental factors (soils, rainfall, etc.) and agricultural practices (sowing date, fertilizer application, etc.). Models can be used to investigate the effects of this diversity on plant-pest interactions.



Modelling yield losses according to bollworm density and infestation date.
© S. Nibouche/PRASAC

Graphic image of cotton plants simulated by the Cotons®-Simbad model. A cotton plant damaged by an early bollworm infestation (left) and a non-infested cotton plant (right).
© CIRAD

Cotons®-Simbad—a unique system combining plant and insect models

Cotons®-Simbad is a computer-based model that combines a cotton growth model (Cotons®) and a cotton bollworm feeding behaviour model (Simbad). It is used to estimate the number and type of bolls attacked and the impact of this damage on the harvest. Cotons®-Simbad was developed on the basis of several years of laboratory and field observations and experiments undertaken to describe the feeding behaviour of the four main bollworm species found in Africa.

For further information

Nibouche S., Martin P., Crétenet M., Jallas E., Turner S., 2003. Cotons®-Simbad system: modeling feeding behavior of cotton bollworms for evaluation of crop pest interactions. *In* Proceedings of the Beltwide Cotton Conferences: 2002-2003 full papers, cotton pest loss database [CD-ROM]. Beltwide Cotton Conferences, Nashville, USA, 2003-01-06/2003-01-10, NCC (Memphis, USA), The Cotton Foundation (Memphis, USA).

Nibouche S., Beyo J., Brévault T., Crétenet M., Gozé E., Jallas E., Martin P., Moussa A.A., 2003. Cotton bollworm economic injury levels based on crop model predictions: another use of the COTONS model. *In* Proceedings of the third World Cotton Research Conference: cotton production for the new millennium, Cape Town, South Africa, 2003 March 9-13, pp. 1 291-1 296 [CD-ROM].

Nibouche S., Beyo J., Brévault T., Crétenet M., Gozé E., Jallas E., Martin P., Moussa A.A. 2002. Cotons®-Simbad: a tool for establishing cotton bollworm economic damage thresholds. *In* Villalobos F.J., Testi L. (eds.) VII Congress of the European Society for Agronomy: Consejeria de agricultura y pesca, Cordoba, Spain, 15-18 July 2002, Junta de Analucia, Seville, ESA, pp. 307-308. ISBN 84-8474-059-5.

Partners

Africa: PRASAC, Pôle de recherche appliquée au développement des savanes d'Afrique Centrale, Chad • IRAD, Institut de recherche agricole pour le développement, Cameroon

France: MAE, Ministère français des Affaires étrangères • PVBMT, Plant Communities and Biological Invaders in Tropical Environments, Université de La Réunion, CIRAD, Réunion

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Cotton and livestock farming in African savanna regions—competition or synergy?

Sub-Saharan savanna regions suitable for cotton growing are gradually turning into livestock rangelands. Cattle herds have been increasing in these areas since the severe droughts that affected the Sahelian region in 1973 and 1984—many Fulani herders have migrated there with their herds along with farmers who grow cotton in newly cleared areas. Land clearing has reduced populations of tsetse flies, the main vector of animal trypanosomiasis, which is a major constraint to livestock farming in these Sudanian savanna regions. In this setting, CIRAD and partners are striving to enhance the productivity of these production systems and the integration of livestock farming in agricultural areas.

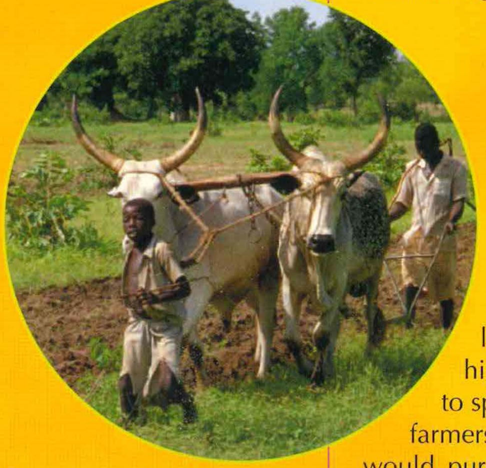
Cropping systems and animal draught

Management of draught oxen was often a cotton farmer's first livestock rearing experience. As of the 1960s, development bodies, including national cotton companies, decided to promote a production model based on animal draught. Extension measures, e.g. provision of trained oxen, equipment credits and veterinary services, have led to a steady increase in the use of animal draught. Currently more than 80% of farms in the Malian cotton-growing area have at least one team of draught animals, as compared to around 65% in Burkina Faso, and 30% in Cameroon where the smallest farms are found.

Livestock on every cotton farm

Most cotton farmers have decided to invest their surplus revenue in livestock (sheep and goats, cattle and, to a lesser extent, pigs) so as to get a better return on their capital than would be possible through other sectors such as trading, crafts and bank investments. After first procuring a team of draught oxen and equipment, 10-20% of cotton farmers have thus been establishing core herds with 5-50 head of cattle or more.

This capital can be readily liberated to cover unexpected expenses or for new investments (house, vehicle, grain mill). In the Koutiala region, a traditional cotton-growing area, a cattle herd also boosts farm sustainability. In the dry season, the herd grazes and tramples on crop residue, such as cereal straw and cotton stems, thus recycling it into organic manure which in turn is essential for fertilizing subsequent cotton-maize crops in rotation. Rangeland is limited during the farming season, so many livestock herds are moved to less populated regions.



Ploughing, northern Cameroon. © P. Dugué

Cottonseed cake—the main cattle feed concentrate

It is crucial to preserve cottonseed cake supplies in these regions for the benefit of livestock farmers. In northern Cameroon, for instance, cottonseed cake accounts for half of the digestible nitrogen feed ration of draught oxen and suckling cows during the second half of the dry season (1 February to 15 May). The high demand for cattle feed concentrates in the dry season has prompted dealers to speculate by purchasing large quantities of cottonseed cake. Cotton and livestock farmers' organizations should offset this threat by setting up systems whereby they would purchase wholesale quantities of cottonseed cake to resell to their members at remunerative prices before this feed is exported abroad.

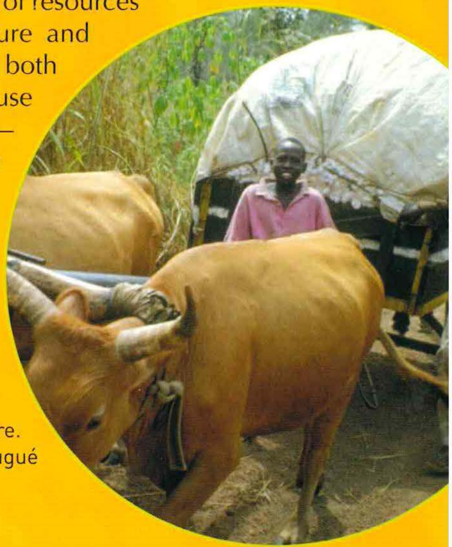
Fulani cattle farming in a cotton-growing area. © P. Dugué

Intensification and land management?

The combined development of extensive livestock farming and cotton production is possible if farmland and rangeland resources are available. Agriculture takes precedent over livestock farming once the population density rises above 50 inhabitants/km^2 and there is no fodder production intensification or village rangeland conservation. The livestock farming potential is still high in sub-Saharan cotton-growing areas, i.e. high protein cottonseed-based animal feed, rainfall conditions suitable for fodder crop intensification, and new markets to capture (milk for urban centres, meat for export). The livestock feed supply could thus be increased, but rangelands must be preserved for cow-calf rearing. Extension services should support local stakeholders by sketching the limits of farming and rangeland areas and creating livestock trails to minimize conflicts between crop and livestock farmers.

Further research

In cotton-growing areas, many technical references are available on fodder crops, and manure, hay and sillage production processes, etc. Based on these resources, CIRAD and partners have set up projects focused on the management of resources that could be utilized in mixed farming systems (agriculture and livestock production). These projects are now under way—on both production unit (increased plant biomass production, optimal use of this biomass, herd management) and area scales—in Mali, Burkina Faso and Cameroon. Tools are proposed to help local stakeholders draw up collective management procedures concerning land and resources shared between crop and livestock farmers.



Cotton in a cart. Korhogo, Côte d'Ivoire. © P. Dugué

Partners

Burkina Faso: CIRDES, Centre international de recherche-développement sur l'élevage en zone subhumide

Cameroon: IRAD, Institut de la recherche agricole pour le développement

Mali: IER, Institut d'économie rurale

Chad: PRASAC, Pôle régional de recherche appliquée au développement des savanes d'Afrique centrale

For further information

Vall E., Lhoste P., Abakar O., Dongmo Ngoutsop A.L., 2003. La traction animale dans le contexte en mutation de l'Afrique subsaharienne : enjeux de développement et de recherche. Cahiers Agricultures 12 (4): 219-226.

Dugué P., Vall E., Klein H.D., Rollin D., Lecomte P., 2004. Evolution des relations entre l'agriculture et l'élevage dans les savanes d'Afrique de l'Ouest et du Centre. Oléagineux Corps gras Lipides 11 (4/5): 268-276.

Dugué P., Koné R., Koné G., Akindes F., 2004. Production agricole et élevage dans le centre du bassin cotonnier de Côte d'Ivoire. Développement économique, gestion des ressources naturelles et conflits entre acteurs. Cahiers Agricultures 13 (6): 504-509.

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Cotton breeding at CIRAD—from conventional selection to biotechnologies

In addition to conventional breeding methods, cotton breeders have access to new biotechnology tools such as marker-assisted selection and genetic transformation which enable them to create new cotton varieties that are higher yielding and generate a better quality fibre. CIRAD has bred cotton varieties for farmers in developing countries which are adapted to local climatic and cropping conditions, and produce a high technological quality fibre suitable for textile manufacturing.

Removal of a flower bud for subsequent hybridization.
© J.P. Brossard

Conventional breeding

Varieties bred by CIRAD, alone or in partnership, are cropped yearly on an area of 2.5 million ha (7% of the area under cotton worldwide). They have been obtained by conventional breeding methods (pedigree selection via stabilization of target traits through several selfed generations in the progeny of a cross between two or several varieties). CIRAD is using these standard techniques, in partnerships in Benin, Cameroon, Brazil and Paraguay, with the aim of obtaining varieties that respond to a broad range of specific adaptations.

Participative breeding

CIRAD, with the aim of taking institutional patterns of cotton subsectors into better account, is involved in a "participative breeding" strategy in Benin, with volunteer farmers participating alongside scientists to select strains in populations during the breeding process. Every year these farmers oversee the sowing of new populations. In the field, they choose plants that they consider to be the most interesting from an agricultural standpoint. The breeding process is then focused on technological fibre traits in collaboration with the scientists. New cotton varieties bred in this way will soon be released to farmers.

Genome mapping and marker-assisted selection

DNA molecular markers are used for direct selection of genes in the plant genome. They can accurately identify and pinpoint chromosome regions containing genes underlying agriculturally or technologically interesting traits—these chromosome areas are called quantitative trait loci (QTLs). Breeders strive to accumulate, within the same plant, all QTLs that seem to underlie genes associated with the target trait—this is called marker-assisted selection (MAS). Varieties can thus be screened directly on the basis of the genotype, i.e. from genes contained in the genome, contrary to conventional breeding strategies based on the phenotype (physical manifestation of a trait in a plant induced by the expression of specific genes). Molecular markers are not sensitive to the medium, contrary to phenotypic expression which can be affected by interactions with the environment.

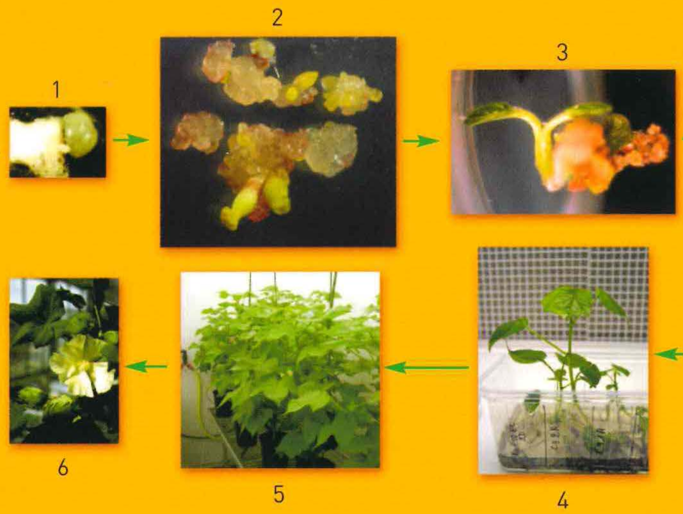
CIRAD's cotton marker-assisted selection programme is currently focused on introgressing a fibre quality QTL from a *Gossypium barbadense* cultivar (cv VH8, which produces a very strong, long thin fibre) into a *Gossypium hirsutum* cultivar (early and high yielding cv Guazuncho 2). QTLs underlying good fibre quality traits were located in around 20 chromosome segments on the cotton genome map. CIRAD breeders hope to enhance the intrinsic fibre quality of *G. hirsutum* through the accumulation of these fibre quality-associated QTLs from *G. barbadense*.

Genetic transformation of cotton

Cotton is one of the first crop plants genetic transformation techniques focused on to obtain commercial varieties. Insect- and herbicide-resistant transgenic varieties are currently grown on 20% of the area under cotton worldwide. They are also being grown to an increasing extent in developing countries. CIRAD considers that it is essential to assess the impact of these varieties in smallholder farming systems in such cotton-producing countries.

The genetic transformation process is being developed for cotton at CIRAD—it is an effective tool for unravelling the complexities of the cotton genome. It can, for instance, be used to determine the function of an investigated gene by introducing a construct of two genetic sequences, with one representing a gene and the other promoting the overexpression or extinction of this gene. CIRAD scientists, in collaboration with the Biotechnology Research Institute in Beijing, China, are using this method to study genes involved in cellulose synthesis and cellular elongation, with the aim of generating cotton fibres with novel features, such as crease resistance and dye receptiveness.

OBTAINING TRANSGENIC COTTON PLANTS



1. Callus obtained by propagation of transformed cells • 2. Embryogenic callus bearing somatic embryos • 3. Young plantlet derived from a developing somatic embryo • 4. Plants transformed prior to potting them • 5. Plants transformed in the glasshouse• 6. Fruits (bolls) and flowers of a transgenic plant

For further information

Hau B., Lançon J., Dessauw D., 1997. Les cotonniers. *In* Charrier A., Jacquot M., Hamon S., Nicolas D. (ed.) L'amélioration des plantes tropicales. Montpellier, France, CIRAD, ORSTOM, Collection Repères, pp. 241-265.

Lacape M., Nguyen T.B., Thibivilliers S., Bojinov B., Courtois B., Cantrell R.G., Burr B., Hau B., 2003. A combined RFLP-SSR-AFLP map of tetraploid cotton based on a *Gossypium hirsutum* x *Gossypium barbadense* backcross population. Genome, 46 (4): 612-626.

Pannetier C., Giband M., Couzy P., Le Tan V., Mazier M., Tourneur J., Hau B., 1997. Introduction of new traits into cotton through genetic engineering. The example of insect resistance. Euphytica, 96: 163-166.

Partners

Africa: IRAD, Institut de la recherche agricole pour le développement; SODECOTON, Société de développement du coton, Cameroon • INRAB, Institut national de recherche agronomique, Benin • SODEFITEX, Senegal • University of Pretoria, South Africa

South America: PIEA, Programa de Investigación y Experimentación Algodonera, Paraguay • EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária; COODETEC, Brazil

China: BRI, Biotechnology Research Institute of the Chinese Academy of Agricultural Sciences, CAAS, Beijing

USA: Brookhaven National Laboratory, Upton, New York

Europe: ENSAR, Ecole nationale supérieure agronomique de Rennes; INRA, Laboratoire de biologie cellulaire of the Centre de l'Institut national de la recherche agronomique de Versailles Grignon; Groupe Dagris, France • Faculté des Sciences Agronomiques de Gembloux, Belgium

ICGI, International Cotton Genome Initiative

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Cotton genetic resources at Cirad

The French Cotton Germplasm Collection—one of the largest in the world—is managed by CIRAD in Montpellier. It currently contains over 3 000 cotton accessions from around 100 countries. These valuable genetic resources can be tapped by breeding and genetic research programmes implementing conventional breeding techniques, interspecific hybridization and marker-assisted selection.

Gossypium genus

Cotton belongs to the *Gossypium* genus, Malvaceae family. This genus consists of 50 classified species, with 45 diploid and 5 tetraploid species. The *Gossypium* genus includes four cultivated species with seeds that produce a fibre which is long enough to be ginned: two diploid species (*G. herbaceum* and *G. arboreum*) and two tetraploid species (*G. hirsutum* and *G. barbadense*). The CIRAD collection contains five tetraploid species and 27 diploid species.

Gossypium barbadense cotton flower.
© D. Dessauw

CIRAD Cotton Germplasm Collection

This collection contains accessions of wild and cultivated species that were collected in their centres of origin and diversification areas, lines exchanged between breeders, obsolete and modern cultivated varieties, mutants and progeny of interspecific crosses. *Gossypium hirsutum*, which is the most widely cultivated cotton species in the world, accounts for 70% of the accessions maintained in the collection.

Cotton seeds are kept in a cold room at 4°C, and thus maintain their germinative capacity for 15 years. CIRAD is also developing a procedure for cold storage at -18°C, so it will be possible to keep the seeds for several decades without damage.

Each accession is "rejuvenated" every 12-15 years by seed sowing and selfing. This rejuvenation process provides an opportunity to conduct or supplement the accession assessments. Seed propagation is carried out under partnerships in different tropical regions.

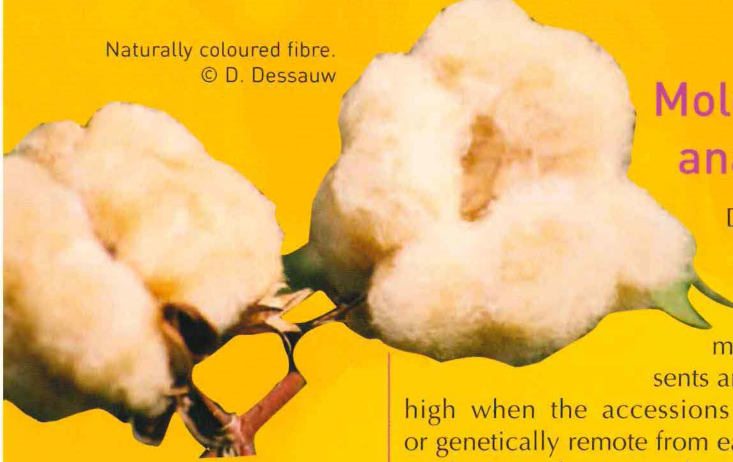
Cold-room storage of cotton seeds.
© D. Dessauw

Genetic variability resources

Normal bracts (left) and atrophied bracts (right).
© D. Dessauw

This collection contains genetic variability that is used by breeders in their cultivated cotton breeding programmes. Genetic variability is high in the *Gossypium* genus, which CIRAD is striving to preserve, utilize and describe. Indeed, there is extremely wide variability in the size, habit, leaf and bract shape, growth rate, technological fibre traits, etc. Breeders have also focused on a wide range of traits.

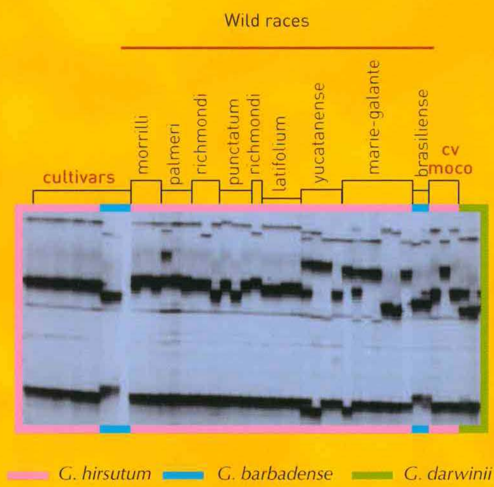
For instance, the fibre of cultivated varieties is usually white, but some cotton varieties produce coloured fibre (brown or green) which is used to manufacture naturally coloured cloth.



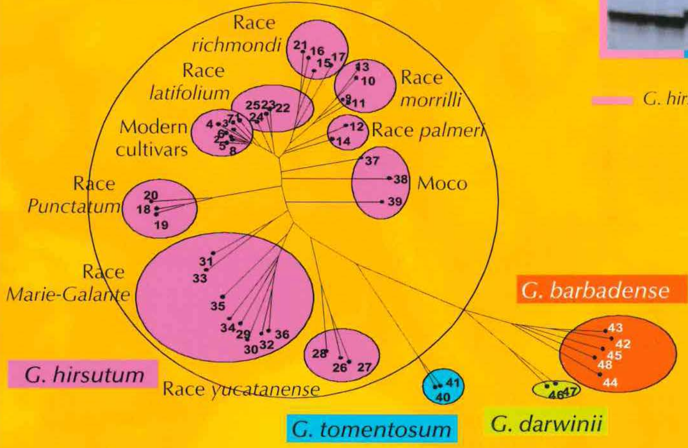
Naturally coloured fibre.
© D. Dessauw

Molecular markers—diversity analysis tools

DNA molecular markers are very helpful for gaining insight into the genetic diversity in the collection and for boosting the efficacy of cotton breeding. These markers are distributed along chromosomes in patterns that generate an image, i.e. a chromosome map. Through the natural mutation phenomenon, each marker presents an array of different allelic forms, and this variability is especially high when the accessions compared are old or genetically remote from each other. Molecular markers are being used to quantify the extent of relatedness between species in the CIRAD collection. Geneticists can thus use this tool to streamline management of the collection, i.e. enhance breeding efficacy and discard redundant types.



Electrophoretogram on acrylamide gel of the microsatellite allelic diversity (three markers) in a collection of 46 tetraploid accessions from CIRAD's gene library.
© CIRAD



Tree diagram illustrating tetraploid cotton species in the CIRAD germplasm collection that were obtained by molecular marker techniques. Each number represents an accession in the collection, with different colours for different species.

Partners

Africa: IRAD, Institut de la recherche agricole pour le développement, Cameroon • INRAB, Institut national de recherche agronomique, Benin

South Africa: PIEA, Programa de Investigación y Experimentación Algodonera, Paraguay • EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária, Brazil

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For further information

Dessauw D., Nguyen T.B., Lacape J.M., Hau B., 2004. Cotton genetic resources at CIRAD. ICGI 2004 Workshop, Hyderabad, India, 10-13 October 2004.

Hau B., Lançon J., Dessauw D., 1997. Les cotonniers. *In* Charrier A., Jacquot M., Hamon S., Nicolas D. (ed.) L'amélioration des plantes tropicales. Montpellier, France. Collection Repères, CIRAD-ORSTOM, p. 241-265.

Lacape J.M., Rajab M., Dessauw D., Hau B., 2004. Microsatellite allelic diversity within tetraploid *Gossypium* germplasm. ICGI 2004 Workshop, Hyderabad, India, 10-13 October 2004.

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Reducing pesticide use—a key challenge for cotton research

Cotton farmers are often accused of overusing pesticides, but they sometimes do not have access to enough information on alternative methods to improve their daily cropping practices and thus reduce some pest damage to their crops. CIRAD is conducting development-oriented research to benefit African cotton smallholders—through participative methods, scientists and farmers are implementing a range of agricultural practices to enhance sustainable pest management.

Damage due to an *Amrasca biguttula* infestation in Thailand. © B. Bachelier

A varied and destructive insect pest complex

More than 1 300 cotton pest species have been identified, including around 500 on the African continent alone. They are responsible for considerable crop losses and depreciate the technological quality of cotton fibre.

From irrational use of pesticides...

Chemicals, especially pesticides, were widely promoted as a cure-all just after World War II. For two decades, pest problems were unquestionably managed with the available range of commercial pesticides. Then the American writer Rachel Carson published *Silent Spring* in 1962, which reflected the growing public awareness on the unintentional detrimental health and environmental impacts of chemical treatments.

Meanwhile insect resistance to pesticides was rising. There was an irrational concomitant increase in treatments, which forced farmers to give up cotton cultivation in some countries like Mexico, Nicaragua and Thailand.

...to sustainable pest management

Helicoverpa armigera destroying a young boll. © CIRAD

Since then, different methods have been developed to reduce the dependency on pesticides in agriculture, and particularly in cotton cropping systems. These methods use thresholds as a basis for pesticide control management. Progressive farmers make decisions according to a tolerance threshold, which is reached when the plant is no longer able to offset losses due to insect infestations, and an economic threshold, which takes the costs directly and indirectly associated with crop pest control treatments into account.

Pentatomid bug attacking a caterpillar. © CIRAD

It is now considered that, as a complement to chemical treatment strategies, pest control sustainability could be improved by implementing a range of techniques. These were initially referred to as 'integrated pest control' and then extended to include the integrated crop management concept. This management is based on:

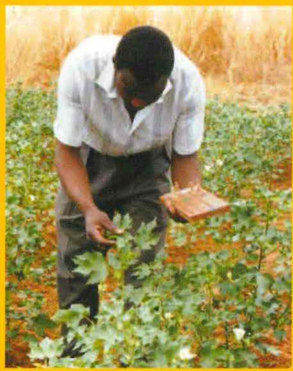
- nurturing the rich natural insect fauna. Diseases and insects that attack cotton pests are found in cotton fields. These beneficials should be identified and taken into account when establishing treatment thresholds. They could even be propagated and mass released in cotton fields;

Industrial production of the bacterium *Bacillus thuringiensis*, an insect pathogen.

• using resistance traits in cotton plants, i.e. naturally occurring or inserted in new varieties by biotechnological procedures. Wild cotton species have morphological (leaf shape and hairiness) and biochemical (high tannin and phenolic compound contents) traits that can be transferred to crop varieties to reduce the development of some pests. Genetic engineering currently facilitates the transfer of genes from the bacterium *Bacillus thuringiensis* into cultivated cotton varieties, and the resulting plants produce insecticide proteins. This technology could markedly reduce the need for chemical treatments to control bollworms;

• adopting cropping practices that enhance plant health. It is essential to focus on creating the best conditions for plants to thrive and produce cotton. The right choice of sowing date, seed quality, balanced fertilization and weed control would thus help cotton plants to effectively avert pest attacks;

• implementing a rational approach to chemical pesticide use. Treatments are only necessary when pests have overcome these impediments and are threatening cotton yields and quality, and thus farmers' income. In such cases, farmers should conduct a pesticide treatment using an active ingredient that is selected on the basis of its efficacy and specificity against the target pest insect.



Pest and disease assessment in a cotton field in Cameroon.

A participative scientist-farmer approach

In Africa and South America, CIRAD and national partners have developed participative methods through farmer field schools (based on the FAO model) for knowledge transfer to users. This approach also boosts scientists' awareness on local know-how, which they can subsequently take into consideration when drawing up technical recommendations on pest control techniques.

Discussion around a pegboard about the pest infestation level in the field in Mali.

Partners

Africa: INRAB, Institut national des recherches agricoles du Benin • IRAD, Institut de la recherche agricole pour le développement, Cameroon • IER, Institut d'économie rurale, Mali

South America: PIEA, Programa de Investigación y Experimentación Algodonera, and Arasy, a NGO, Paraguay • EMBRAPA, Empresa Brasileira de Pesquisa Agropecuária; and COODETEC, Brazil

For further information

Hofs J-L., Fok M., Vaissayre, M. 2006 - Impact of Bt cotton adoption on pesticide use by smallholders: A 2-year survey in Makhatini Flats (South Africa). Crop Protection, 25: 984-988.

Martin T., Ochou G.O., Djihinto A.K., Traore D., Togola M., Vassal J-M., Vaissayre M., Fournier D, 2005. Controlling an insecticide-resistant bollworm in West Africa. Agriculture, Ecosystems & Environment 107: 409-411.

Prudent P., Loko S., Deybe D., Vaissayre M. 2006 – Factors limiting the adoption of IPM practices by cotton farmers in Benin: a participatory approach. Experimental Agriculture, 43: 1-12.

Silvie P., Deguine J.P., Nibouche S., Michel B, Vaissayre M., 2001. Potential of threshold-based intervention for cotton pest control by small farmers in West Africa. Crop Protection 20: 297-301.

Vaissayre M., Ochou O.G., Héma O.S.A., Togola M., 2006. Quelles stratégies pour une gestion durable des ravageurs du cotonnier en Afrique subsaharienne ? Cahiers Agricultures 15 (1): 80-84.

CIRAD
at a glance

CIRAD, the Agricultural Research Centre for International Development, is working in developing countries and the French overseas regions. Most of its research is conducted in partnership.

CIRAD has chosen sustainable development as the cornerstone of its operations worldwide. This means taking account of the long-term ecological, economic and social consequences of change in developing communities and countries.

CIRAD contributes to development through research and trials, training, dissemination of information, innovation and appraisals. Its expertise spans the life sciences, human sciences and engineering sciences and their application to agriculture and food, natural resource management and society.

It employs 1 820 people, including 1 050 senior staff members, and has an annual operating budget of 200 million euros.

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Several hundred million people are working in the cotton cropping sector worldwide. In developing countries, more than 100 million farming families live on income generated by this crop.

Cotton is one of the key driving forces of development in West and Central Africa. The group of French-speaking countries in this geographical area represents the second ranking cotton exporting region in the world, despite the harsh setting—productivity has stagnated and cotton subsectors have been upset by market liberalization, agricultural subsidization of the cotton industry in some large producing countries, and declining world prices.

In this uncertain environment, enhancing the competitiveness and sustainability of cotton cropping is vital for African countries. CIRAD is striving to achieve this goal by conducting research projects in partnership with national research institutions, universities, training organizations, cotton enterprises, private stakeholders and farmers' organizations.

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