

Cotton roadmap summary

The road to sustainable cotton growing [2023-2033]



The road to sustainable cotton growing [2023-2033]

For five thousand years, cotton has been inextricably linked to the history of humankind through its cultivation, the use of its products and trading operations. It is currently grown on every continent, and provides the world's leading natural fibre. The sector is facing new challenges including climate change as well as social and environmental issues. To address those challenges, CIRAD has pinpointed four ambitions that will frame its cotton research over the coming decade. ■

Four species of cotton (*Gossypium sp.*), a perennial shrub primarily grown as an annual crop, are cultivated, in some sixty countries. It is grown both on large, intensive, mechanized farms and by smallholders on family farms using manual labour. The product harvested, seed cotton, comprises seeds with attached fibres. The first processing operation, ginning, is done in the areas where the cotton is produced. It consists in mechanically separating the fibres from the seeds. The cellulose-rich fibres are a bioproduct mainly intended for the textile industry. The seeds, which contain oil and protein, are used in the food, feed and cosmetics industries.

A polarized sector with significant disparities

The cotton sector is characterized by the large number of stages and products involved. It also brings together a range of operators: producers and their organizations, production support services, processing firms (ginning, spinning, weaving/knitting, dyeing,

sewing, seed crushing, etc), grading services (in charge of making up lots of uniform fibre quality), marketing operatives, input and agricultural equipment suppliers, agricultural research services, etc. The fibre accounts for some three quarters of the financial revenue generated from cotton. It is a commodity listed on the world's leading stock exchanges. With a total of around 25 million tonnes produced each year, cotton is currently the world's leading natural fibre in volume terms and the second textile fibre, behind oil-based synthetic fibres. The main producing countries – China, India, the USA and Brazil – account for some 70% of total global output, while Africa in its entirety produces less than 10%. Asia consumes 90% of the world's cotton fibre in its textile industry. Average fibre yields worldwide are around 775 kg/ha, albeit with substantial geographical disparities. While the figure is more than 1000 kg/ha in South and North America, East Asia, Australia and Europe, the lowest yields are achieved in West and Central Africa (less than 500 kg/ha) and East and southern Africa (less than 300 kg/ha).

A range of challenges

CIRAD's work on cotton is conducted in partnership, mainly in Africa. We have pinpointed several challenges the sector needs to tackle in the coming years. The first is to reduce the environmental and health impacts of both cotton production and industrial processing. The second is to adapt cotton growing to climate change while limiting its effects on climate. Thirdly, the profitability of the sector, particularly at the production stage, must be improved. Fourthly, it is vital that the sector make a greater contribution to the wellbeing of stakeholders in the sector and of their families, since although cotton growing plays a major role in reducing food insecurity, there is still room for improvement. The fifth challenge involves strengthening R&D structures, players and operations. Lastly, it is important to improve the image of the cotton sector in the eyes of the general public, by communicating better about the specificities of cotton growing in Africa and by demonstrating the merits of cotton fibre production in relation to other textile fibres. ■



© M. Giband, CIRAD



© B. Bachelier, CIRAD



© B. Bachelier, CIRAD

Making cotton systems in Africa sustainable: four ambitions to frame operations

CIRAD is a historic player in cotton research, backed by long-term partnerships with players from the research, development and agroindustrial sectors. Our activities cover every stage from plot to initial industrial processing, and rely on our expertise in the fields of genetics and plant improvement, crop management, processing, and product quality. CIRAD is also involved in supporting, training and mentoring players in the sector. Seven research units from all three of our scientific departments are working on cotton, focusing on biological systems (BIOS department), tropical production and processing systems (PERSYST department), and environments and societies (ES department). Those departments' resources will serve to work towards the four ambitions set.

Ambition 1

Adapt cropping practices to climate change and reduce their environmental impact

Lever already exist to encourage climate change mitigation and adapt to the effects of that change. CIRAD recommends stepping up the development of innovative methods and making use of ecological intensification processes to reduce the environmental impact of cotton-based cropping systems, thanks to water and soil conservation, soil fertility restoration and pest control techniques. In particular, the aim is to recycle plant biomass (biochar) and animal biomass (from livestock production) and use "push-pull" methods, biopesticides or more resilient varieties. To ensure their adoption, this change in cropping techniques has to be made hand-in-hand with producers by generating and sharing knowledge. This means making it easier for them to access technical know-how and innovations.

Ambition 2

Make African cotton more profitable and competitive

Keeping cotton growing attractive means boosting and stabilizing the income generated. Developing high-yielding varieties adapted to more resilient production systems is one approach CIRAD will be using to improve the productivity of cotton systems. That improvement will also benefit cotton companies, whose profitability and competitiveness also rely on cutting production costs. Mechanizing operations could provide technical solutions. Exploiting and promoting the technological quality of the products made and the production methods used in African cotton chains and developing chains with a specific identity are also ways of making the sector more competitive and boosting cotton farmers' incomes.

Ambition 3

Build capacity among players in African cotton chains

Through this ambition, CIRAD aims to promote collective, co-constructed global operations to benefit national cotton chains, and share progress to build capacity

among players on a national and regional level. On a value chain scale, the objective is to foster equity with a view to improving competitiveness. This ambition centres on (i) promoting and implementing tools and methods in support of concerted approaches, (ii) developing frameworks to optimize progress sharing and (iii) building stakeholder capacity and differentiated, inclusive support and advisory services.

Ambition 4

Position African cotton chains better on a territory scale

There are significant interactions between cotton growing and social, production, environmental and economic systems on a farm and territory scale. It is important to use our knowledge of those interactions to devise innovative solutions to guarantee the sustainability of cotton systems. Through this ambition, CIRAD hopes to contribute to co-constructing bespoke cotton system innovations for different scales. The aim is to address current global issues and foster the resilience and food security of farms, communities and territories. This is vital for sustainable food and farming systems. ■



© M. Giband, CIRAD

Details

Adapting cropping practices to climate change, making African cotton more profitable and more competitive, building skills and repositioning cotton chains on a territory scale, etc... a look at the key details of the cotton roadmap with geneticists and breeders Bruno Bachelier and Marc Giband, CIRAD cotton research coordinators.



What are the main levers for adapting cropping practices to climate change?

B.B. and M.G.: In Africa, climate change will undoubtedly affect temperature, atmospheric CO₂ levels and rainfall, with a subsequent impact on cotton growing, particularly in terms of yields, precocity and pest and disease pressure, as we are already seeing with the emergence of a new species of cotton jassid, *Amrasca biguttula*. Adapting to such disruption and mitigating its adverse effects calls for sustainable cotton growing systems, to help conserve resources and biodiversity. There are several ways of going about this. The first concerns sustainable land management, by means of ecological intensification of cropping and production systems, to control biomass flows on a territory level. The second concerns soil organic matter management, which affects water

retention, erosion and nutrient availability. The third way is agroecological management of pests and diseases, by preserving functional biodiversity. Lastly, the fourth way concerns varieties: breeding early varieties that are both compact and tolerant of environmental constraints and new cropping systems.

How can African cotton be made more profitable?

Profitability means different things to different people in the sector, but everyone should be able to profit from their work in the long term, by optimizing their costs and income. For producers, the development of bespoke varieties and the availability of quality seed, mechanization of cropping operations (including exploiting the potential of animal draught or motor-drawn equipment), from sowing to applications (fertilizers, herbicides, insecticides) and weeding-hoeing, and even to harvesting, can provide technical solutions and help maintain the attractiveness of cotton growing. For cotton firms and ginners, profitability and competitiveness mean boosting production (of seed cotton and products made from it), in terms of both quantity and quality, and cutting production costs. For the crushing industry, cottonseed by-products (oil, seed cake, etc) could be promoted more effectively if marketing chains were more organized.

Why is building consultation and discussion instruments within the cotton sector in Africa a priority?

Cotton chains involve a large number of players, with sometimes different, even diverging aims and interests. Their ability to organize consultation also varies.

In an overall context of State withdrawal from the operational management of production chains, the challenge is often to set up inter-professional governance, to steer those chains more efficiently and facilitate forward thinking. This includes building the capacity of players, particularly producers, by means of training and professionalization operations. In Africa, in addition to national visions, regional consultation and discussion instruments are emerging. Knowledge- and strategy-sharing structures are being developed for research organizations (PR-PICA), producers (APRoCA), regional coordination (UEMOA, ECCAS), technical coordination bodies (ICAC) and cotton companies.

What is meant by a new cotton system tailored to farms and territories?

On a farm level, innovation may mean disseminating varieties adapted to biotic and abiotic environmental changes, increased use of other crops (cereals, legumes, service plants), either in rotation or inter-cropped with cotton, topping cotton plants to reduce the need for pesticides, rational motorized cropping, etc. On a territory scale, innovation involves expanding the role of livestock production in agricultural and pastoral land use planning, in terms of soil fertility management and water availability, optimum land use and developing specialized agroecological or organic production zones. This scale also includes organizing stakeholders and fostering consultation between them, by means of producer groups, empowering women producers, encouraging relations between crop and livestock farmers, etc. ■

Find out more: cotton@cirad.fr

Adapting innovations for resilience to climate change for smallholder cotton farmers in Africa – the AIRCoA project

Some 95% of African cotton farms are rainfed, which means smallholders are extremely vulnerable to the likely effects of climate change. The AIRCoA project aims to adapt three scientific innovations that have proved themselves in other parts of the world for use in sustainable, climate-smart smallholder cotton production systems in Africa. Those innovations fall into three categories: i) conventional (non-GM)

varieties tolerant of climate hazards and suitable for high-density cropping systems, ii) soil health rejuvenation by means of carbon capture in the form of biochar made from crop biowaste, and iii) local development of encapsulated botanical biopesticides. They are sustainable and biodiversity- and eco- friendly. They have the potential to boost farmers' incomes substantially, and

to foster enterprise. The project is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by ICAC and CIRAD on behalf of the Deutsche Gesellschaft für Internationale Zusammenarbeit [GIZ].

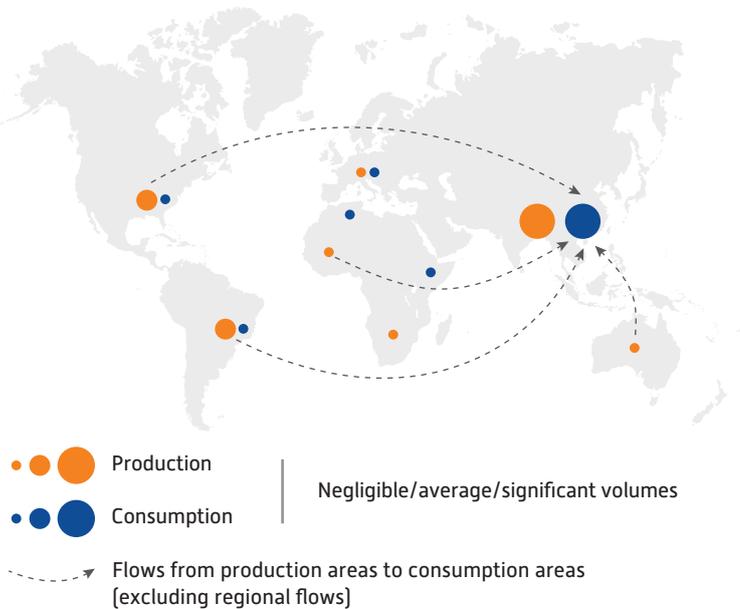
Find out more:



Inventing the cotton sector of the future

CIRAD is addressing the challenges facing the value chain

Global raw cotton production and consumption: polarized flows



Focus on Africa: a crop of major importance...

In West and Central Africa, **16M people earn money from cotton.**

In Benin, Burkina Faso, Mali, Chad and Togo, **cotton exports make a major contribution to GDP: from 5 to 15%.**

... yet fragile



The lowest yields in the world



Almost exclusively rainfed plantations, dependent on climatic conditions



Very limited local processing capacity (>90% of raw cotton is exported)

Our ambitions...



Adapt cropping practices to **climate change** and **reduce** their environmental **impact**



Make African cotton more **profitable** and **competitive**



Build capacity among players in African cotton chains



Position African cotton chains **better** on a **territory** scale

... in partnership

CIRAD is a member of **the International Cotton Advisory Committee (ICAC)** and

- of many national agricultural research systems in Africa,
- of national cotton companies and
- of international agroindustrial groups.

It contributes to **the regional integrated cotton production in Africa programme (PR-PICA)**, along with other partners, interprofessional groups, associations, etc.

Our means and resources

35

scientists from 7 research units

8

disciplines involved, from the agricultural sciences to the social sciences

165

publications in scientific journals between 2018 and 2023

1

of the world's major cotton genetic resource collections: the **GAMET BRC**

Partnerships, the core of CIRAD's research

CIRAD has a long history of cotton research. While in the past, its activities in favour of the cotton sector encompassed Africa, South America, Central Asia and Southeast Asia, in recent years, they have focused on Africa. Its work has always been built on national, regional and international public and private partnerships with research structures, producers' organizations, development bodies and processing companies, in association with various types of donors. CIRAD intends to continue with this geography- and partnership-based strategy in the coming years. ■



© K. Naudin, CIRAD

A word from our partners



Interview with Emmanuel Sekloka,
Director General of
the Institut de recherche
du coton, Benin

What is the history of the partnership between the Institut de recherche du coton (IRC) and CIRAD?

The IRC is a private research institute founded in 2019 by the Association interprofessionnelle du coton (AIC). It took over from the Centre de recherches agricoles – Coton et fibre, which was previously in charge of cotton research in Benin and was one of CIRAD's long-standing partners. The IRC is delegated to perform a public service mission under the aegis of the Ministry of Agriculture, Livestock and Fisheries (MAEP). This was what prompted the MAEP, in February 2020, to call upon CIRAD's expertise to further applied cotton research in the country and help build

local capacity in terms of agronomy, entomology, cotton genetics and technology scaling. The objective was the assignment of four specialists in those fields. IRC and CIRAD subsequently signed an initial hosting and collaboration agreement for the period July 2020–June 2023. Following the success of the first phase, the agreement was extended in October 2023 for a further three years.

How do you feel about the ambitions set out in the CIRAD cotton roadmap (particularly ambitions 1 and 2)?

These ambitions fit perfectly with the current challenges facing the cotton sectors in West and Central Africa. The cropping practices used until now were developed at a time of less degraded soils and less erratic climate conditions. While those management sequences have proved themselves, they are no longer appropriate. IRC and CIRAD are therefore working to build more suitable agroecological crop management sequences that are eco-friendly and boost yields on a plot and farm scale. Ambition 2 is also totally relevant insofar as profitability and competitiveness are now vital for the survival of cotton growing in Benin, notably due to competition from new, emerging value chains. ■



Interview with Caroline Taco,
Business Development
Manager, International
Cotton Advisory
Committee (ICAC)

What is the history of the partnership between ICAC and CIRAD?

CIRAD and ICAC go back a long way. France was one of the founding members of our organization, in 1939, and it was only natural that ICAC should begin working with CIRAD's "cotton" component, which also often took an active part in our plenary meetings. In the late 1990s, ICAC and CIRAD worked on several projects headed by the Common Fund for Commodities. We share the same values and development objectives, centring on sustainability and on making cotton producers and other stakeholders more independent. ICAC has technological expertise in terms of cotton production, while CIRAD has experience

of on-farm demonstrations, particularly in the field of cotton breeding in the French-speaking parts of West Africa.

How do you feel about the ambitions set out in the CIRAD cotton roadmap (particularly ambitions 2 and 3)?

They are crucial to ICAC's remit for the coming years. Cotton yields in Africa, estimated at 343 kg/ha in 2022/23, are well below the global average of 764 kg/ha. ICAC is working actively to help its member countries in Africa make up that shortfall. The i4Ag-AirCoA project (see box on page 4) is one current example of our close collaboration. It is working to demonstrate the viability of adapting sustainable, eco-friendly innovations in two West African countries, in the hope of boosting yields and cotton growers' incomes and encouraging enterprise. CIRAD has undisputable experience in terms of plant breeding, molecular biology and agricultural extension in Africa. At ICAC, we firmly believe that providing training and using local resources and knowledge will boost profitability and improve cotton growers' livelihoods, enabling greater prosperity in Africa. ■



Interview with Diallo Ali Badara,
Head of technical services
at the Union nationale
des sociétés coopératives
des producteurs de coton
in Burkina Faso (UNPCB)

What is the history of the partnership between UNPCB and CIRAD?

I have worked at UNPCB since 2009, but was not aware of any specific agreements between CIRAD and our organization before 2021. However, during that time, large numbers of undergraduate and PhD students from CIRAD came to UNPCB to do research. In 2021, an initial agreement was signed linking UNPCB and CIRAD under the umbrella of the FAIR-Sahel project, as members of a consortium of research, academic and NGO partners. The project, which is being rolled out in Burkina Faso, Mali and Senegal, is focusing on agroecological intensification. UNPCB is working at two sites in the humid area, where innovations are being trialled

by researchers from INERA and CIRAD following a diagnosis made in association with smallholders. Volunteer producers have provided plots for experiments, notably of fodder crops, intercropping, rotation and soil fertility.

How do you feel about the ambitions set out in the CIRAD cotton roadmap (particularly ambitions 1 and 2)?

These topics fit neatly with UNPCB's current priorities. There are many factors limiting cotton production, particularly soil impoverishment but also the cost of chemical inputs, which are widely used in cotton growing. Cutting input use and promoting organic fertilizers will not just improve soils but make it possible to benefit more from what food crops have to offer in terms of greater food security for cotton producers. However, ambition 2 is also very important for UNPCB. Our members – cotton producers – are very concerned about the quality of their cotton. The Burkina Faso cotton producers' association AICB, which associates producers and cotton firms, is in charge of such aspects. AICB has research projects aimed at improving production by using improved seeds and pest control products, and is working to improve agricultural advice services for producers. ■



CIRAD is the French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions.

CIRAD works with its partners to build knowledge and solutions and invent resilient farming systems for a more sustainable, inclusive world. It mobilizes science, innovation and training in order to achieve the sustainable development goals. Its expertise supports the entire range of stakeholders, from producers to public policymakers, to foster biodiversity protection, agroecological transitions, food system sustainability, plant, animal and ecosystem health, and sustainable development of rural territories and their resilience to climate change.

CIRAD is a public establishment (EPIC) under the joint authority of the Ministry of Higher Education and Research and the Ministry for Europe and Foreign Affairs.

CIRAD hopes that multi-stakeholder partnerships and alliances will discuss, share and support its four ambitions for sustainable cotton growing. Contact us to find out more:

cotton@cirad.fr

Working together for tomorrow's agriculture

Find out more about the cotton value chain at CIRAD



cirad.fr



CIRAD is a founding member of:

