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Climate Change: Impact on Cotton production in Pakistan

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Abstract

Climate change is the worst threat to agriculture and industries related to agriculture these days. Factors such as high temperature, disturbed rainfall pattern, drought stress, floods, and precipitation directly affect the agriculture industry mainly in developing economies like Pakistan. Pakistan is an agriculture country, and it is amongst those countries which are greatly affected by climate change. Cotton is one of the main cash crops and among the few main effected crops who are adversely affected by climatic changes. Pakistan is fifth largest producer of cotton in the world with 8.329 million bales during 2021--22. Along with fiber, cotton seed oil is also very important by product that fulfils almost 18% of oil demand in country. Cotton production is affected by temperature fluctuations, unseasonal rains along with other biotic factors. Different studies on impact of climatic changes at different stages in cotton along with some future strategies and recommendations including breeding and agronomic practices to overcome losses are reviewed and presented in this article.

Keywords: Precipitation; Global warming; Molecular markers; heat stress

Introduction

Agriculture is considered as the backbone of Pakistan. It contributes about 22.7 % to the gross domestic product (GDP) and gives employment to about 37.4 % of the labor force. Cotton (*Gossypium hirsutum* L.) is one of the main cash crops and its contribution in overseas earnings of Pakistan are almost 60% and about 0.8% to GDP with an additional 4.5 percent in agriculture value addition (Rana *et al.*, 2020). So, with multiple uses or products. Pakistan is the fifth largest producing country with 8.329 million bales production and area under cultivation of 1937 thousand hectares (Pakistan economic survey 2021-22). Cotton has several by-products of which also contribute a huge share in fulfilling the local demand of oil, feed, and fuel. Main product of cotton is lint that is used in textile industry for manufacturing of clothes. From cotton seed, oil is extracted which is used in cooking and its remanent i.e., seed cake, is used as animal feed. As most of the cooking oil is imported from abroad, so cotton seed oil help in reducing import bill by fulfilling almost 18 % need of cooking oil (Siyal *et al.*, 2021). From time of sowing to harvesting, this crop faces several problems like diseases, insect-pest attack, weeds competition, abiotic stresses such as drought, waterlogging, salinity etc.

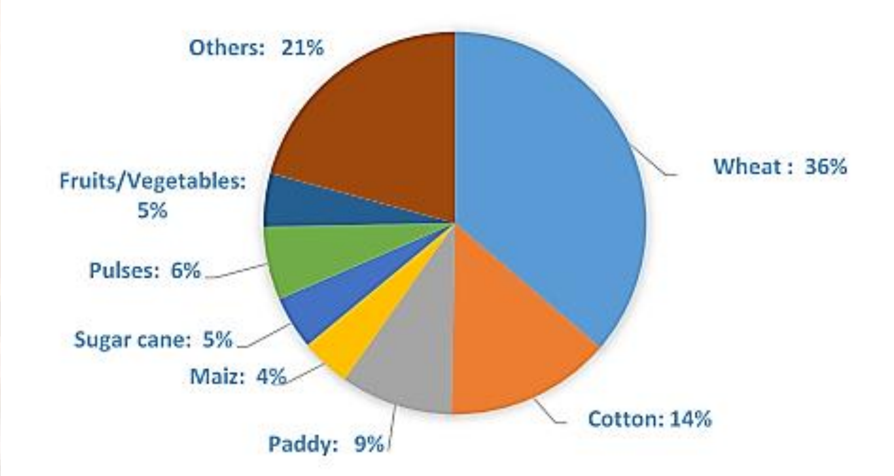

Fig.1 Percentage of area under different crops.

Climatic changes are happening at a very fast rate since the 19th century due to excessive usage of fossil fuel, deforestation, and abundant emission of gases like CO_2, CH_4 etc. These changes cause global warming, untimely precipitation, uneven distribution of rainfall, drought, and floods, melting of glaciers, extreme weather conditions etc. Along with numerous effects on other aspects, climate change also has great effect on Agricultural biodiversity. Few important aspects will be discussed in detail.

High temperature effect

Rise in temperature is one of the main characters of climate change. Elevated temperature effects cotton, almost at every stage of growth. Optimum temperature for germination of cotton seed is about 28-30 °C (Majeed *et al.*, 2021). Temperature greater than 38 °C causes serious decrease in germination percentage (Krzyzanowski *et al.*, 2011). As germination is a complex physiological process so along with air temperature some other factors such as soil temperature and soil moisture also have serious effects on plant. The most temperature effected stages of cotton are early and lateral vegetative growth stages and flowering stage. After good germination, the uniform and brisk emergence of seedling is very important for efficient growth and development of crop and better yield (Parera *et al.*, 1994). The resistance against heat stress varies across species to species and variety to variety.

Fig.2 Adverse effects of heat stress on cotton plant.

Mostly seedlings perform better around 30°C and start to be affected as temperature increases above 40°C. Above 50°C seedlings survival rate approaches to almost zero. Although cotton plants have tap root system and is resilient to drought and temperature stress, but this is up to an optimal level. When temperature goes above that optimal condition, it has negative effects on crop. According to different studies the vegetative and flowering phases of cotton are more sensitive to environment and hence are greatly influenced by fluctuations in surrounding. That is why cotton yield and area under cotton production is decreasing with time. The present discussion will focus on the impact of climate at different vegetative and reproductive stages of cotton and the future strategies for improvement of production and to minimize the losses.

Along with above ground portion, the roots are also affected by rise in temperature. In the damaged roots, the nutrients and water uptake activity are minimized that can ultimately cause reduction in yield. The tap root system develops poorly under heat stress so crop performance is affected and may also result in lodging. Roots growth remains best up to 35°C and starts to be affected when temperature starts to rise from 35°C. At 45°C, irreversible damage appears to root (Sethar *et al.*, 2001). As the cotton is cultivated in April-May, seedlings can bear low temperatures as compared to lateral growth stages which can bear wide temperature ranges of the season. Heat stress also affects the number of fruiting branches in plants. Bud initiation stage faces the highest heat stress and if temperature reaches above the tolerance level, the buds start to drop without development of fruits, and causes severe yield loss problem. Floral buds, flowers and even bolls under development can fall due to high heat stress condition. As heat stress cause deficiency of water and nutrients in plant, so to balance the availability and requirements, plants start to shed the fruit orsss boll. About 50% of fruit shedding can be caused by heat stress and could increase more if the stress level increases (Majeed *et al.*, 2021). At flowering stage, receptivity of stigma and the viability of pollens are the worth important characters as this is the crucial stages for pollination and seed setting. Pollen tube length starts to decrease at above 32°C and pollen tube formation stops when temperature reaches 44°C. The germination of pollens failed above 47°C (Kakani *et al.*, 2005). After pollination, the boll development and boll size also affect by heat stress. The bolls formed at temperature above 40°C have reduced and small size in comparison to those which developed under 40°C (Karademir *et al.*, 2012). Overall, each point rise in temperature above 40°C at flowering stage seriously effects the cotton production and yield.

Besides the growth stages, physiological traits of cotton are also affected by rise in temperature. Due to heat stress condition, the deactivation of Rubisco enzyme causes reduction or even inhibition of photosynthesis process (Karademir *et al.*, 2018). Stomatal activity is also directly associated with the rising temperature. Increase in stomatal activity, increase the transpiration rate, and causes cooling effect which helps in reducing the heat stress. But this activity ultimately causes water shortage due to excessive transpiration rate and plant ultimately goes toward closure of stomata to stop this water loss. So stomatal activity increases up to 40% with increase in temperature, but this happens only up to a certain limit of temperature i.e., 40°C, and above this, the activity starts to decrease and eventually stops (Urban et al., 2017).

Along with quantity, the quality of cotton or fibre is very important for breeders as both characters collectively decide the income of producer. As both these characters, quality, and quantity, are polygenic and have negative association between them, so it is very difficult to fix both characters together (Yaqoob et al., 2016). Heat stress condition of about five days does not significantly affect the fibre quality but if these conditions persist more than seven days, it starts to damage the cellulose and fibre quality of cotton crop (Bo *et al*., 2017).

High Co_2 concentration

In the 21st century it is observed that concentration of CO_2 continues to rise (Le Quéré *et al*., 2009). Increase in CO_2 concentration in the environment and the high temperature are directly related to one another. But being C3 type plant, cotton is not negatively affected by higher concentration of carbon dioxide in the environment. Cotton grows well even at 820 ppm of CO_2 and can use high level of CO_2 of up to 900 ppm (Hughes, 2021). Plants absorb CO_2 and sequester carbon in their biomass. Cotton plants use CO_2 and H_2O to create cellulose, hence cotton is effective in reducing carbon dioxide concentration in environment. But if we see carbon dioxide in other aspect, CO_2 is the main heat trapping gas in atmosphere, which ultimately affect cotton crop. An experiment was performed to check combined effect of CO2 and temperature on cotton canopy photosynthesis and its water use efficiency. At high CO_2 concentration, water use efficiency increased at all temperatures. Increased photosynthesis at higher CO_2 concentration results as high dry matter accumulation (Reddy *et al*., 1995).

Water stress

As the result of global warming, overall temperature is increasing gradually, so the water requirement is also increasing day by day. According to Asian development bank report, water sector is one of the most susceptible sectors to climate change in Pakistan. Usage of water is understood from the fact that 92% of water is used in agriculture sector, 3% industries and 5% in domestic use (Talpur et al., 2020) Climate change effect water sector in the way that high temperature increases the evaporation and transpiration rate, so water requirement is increased eventually. Every passing year, unpredictability in the glacier melting and river flow increases. Moreover, variability in the occurrence and intensity of rainy seasons (monsoon and winter rain) also creates lot of flood related problems. Hence the storage capacity for water is also running short gradually due to increased sediment (0.2 MAF/ year) (Chaudhry, 2017).

Although cotton is grown in warm areas of Pakistan (Provinces of Punjab and Sindh) and due to tap root system and other physiological characteristics, it has some resilience against water or drought stress, yet there are significant losses are being reported due to water shortage. Drought acutely affects the growth and development mechanism of cotton by affecting and restricting germination percentage, root development process, stem and leaf dry weight, number of nodes, plant height and quality of fibre (Loka *et al*., 2011). Water potential of cotton leaf and rate of transpiration, photosynthesis and stomatal conductance also decreases due to drought stress (Kumar et al., 2001). A study showed that identical cotton plants when exposed to drought stress showed about 50% low yield as compared to those under normal irrigation. The effect of drought is more acute during the period of flowering and boll formation as compared to seedling and vegetative stage (Saranga *et al*., 2004).

Insect pest of cotton

Climatic adversities have developed resistance in insect pests and increase in their population at alarming rate. Insects are poikilothermic organisms, hence temperature is one of the most important abiotic factors which affects their distribution, reproduction, development and behavior (Kocmánková *et al*., 2009). The effect of rising temperature is more on aboveground ones than those who remains in the soil for most of their life, because soil act as thermally insulating medium which can buffer change in temperature and hence its effect is reduced (Bale *et al*., 2002). One of its examples is that, under high temperature conditions, aphids are less susceptible to the alarm pheromone they release on threat by predators and parasitoids, which causes increased predation 52. Changing climate makes the insect pest strains of cotton not only stronger against insecticides but secondary insect pest becomes the primary pests of cotton (Tripathi *et al*. 2016). Due to changing climate prevalence of different pests are arising and moving to new and different regions, like shifting of *Helicoverpa armigera* to legumes crops. Insects not only become more invasive but changed phenology of host plants favor the different insects and pests. Insects' pests grow more rapidly under high temperatures as their life cycle becomes short under high temperatures. Continuous rises of temperature increase the survival rate of insects. (Sharma, 2010) whitefly population is dependent on abiotic factors like humidity, temperature, and precipitation. Its population positively correlates with increased temperature and humidity (Pathania *et al*., 2020). Whitefly population decreased during heavy rain and Pink bollworm goes in dormant stage under cool climatic conditions, (Reiners et al., 2005)

Effect of increased radiation

The ozone layer's depletion has been shown to continually increase ambient ultraviolet-B (UV-B) radiation. Enhanced UV-B radiation drastically affects the plant developmental stages, growth, metabolism, mainly photosynthesis. Climate change enhances UV-B radiation which affects cotton leaves, stems and specifically dry matter accumulation. Cotton is sensitive to UV-B radiation, as evidenced by the lower vegetative and reproductive characteristics and smaller canopy caused by high UV-B exposure.(Qi et al., 2017). Effects of enhanced radiation are more on seedling stage than later growth stages of cotton plant. Net photosynthetic rate which ultimately affects seed cotton yield are badly affected by UV-B radiation. On continuous exposure to increased UV-B, the initial chlorotic symptoms on leaves progressed into necrotic regions (Zhao *et al*., 2004)

Climate change and yield of cotton

Pakistan due to its geographical location, most severely impacted by climate change especially catastrophic floods due to melting of glaciers which have destroyed millions of acres of arable land. Due to this a huge area under cotton fields also destroyed, and severely impacted export of textile industry. At the start of the monsoon season in June 2022, rainstorms started to flood parts of Pakistan. Over 30 million people were affected by the deadly floods and landslides brought on by the excessive rainfall. Estimated financial losses to Sindh's agriculture industry at around Rs 500 billion, putting Pakistan's food security is in danger. Even though it is difficult to determine area of cotton crop damage because of this year's flooding and rains, it is estimated that 45% of cotton has been affected by flood, which has caused serious concern among the local textile and cotton industry, as well as among international clothing brands and retailers. Even though farmers haven't been able to complete many of their regularly scheduled agricultural tasks to harvest cotton even 4 months after floods as flood water is still in their fields (Ashraf *et al.*, 2013).

Future recomendaciones

Cotton is the main cash and fibre crop of Pakistan and much of the labour force is directly or indirectly attached to it. So, there is lot of work needed for its survival and improvement. Firstly, the work should be done to restrict or at least slow down the adverse effects of climatic changes on plant yield.

From an agricultural point of view, there is need to educate farmers for proper use of fertilizers, pesticides, and water sources. Efficient and precision usage of water will also help to survive in drought stress situations. Modification in agronomic practices will also be useful to cope with stress. Adjustment of sowing time according to climate, use of best suitable sowing design and method according to available resources (water, machinery, inputs, labor) is a wise approach. Farmers should perform regenerative agriculture practices like zero tillage or no-tillage, inhibiting burning of stubbles, plantation of cover crops will help to keep soil in good condition and perform better under drought condition as well as erratic rainfall.

Along with agronomic practices, development of heat and drought resistant cotton varieties by using conventional methods as well as modern biotechnological tools is also important. Development and introduction of better mechanism for heat shock proteins would be very effective against heat stress. In conventional breeding, diverse germplasm is of much importance. Screening of wild species and relatives is recommended for diverse gene pool (Majeed *et al*., 2021). Transfer of desirable gene from is difficult and not always possible through conventional breeding method. But molecular markers and biotechnological tools have made it much easier these days. Several markers like AFLP, RAPD are being used for screening of heat resistant genotypes (Mohamed *et al*., 2013). SSR and SNPs are also being used for QTLs related to heat and drought stress (Majeed *et al*., 2019). Transgenic techniques could also be very useful for breeding against stresses of heat and drought. CRISPR-Cas9 technique for targeted genome editing could be much helpful in advance cotton breeding programs.

As climate is changing at rapid speed since the start of 19th century and more dominantly from previous decades so it is mandatory to know its reason, effects and develop future strategies. As cotton crop is the source of earning for more than half of the population of Pakistan directly or indirectly and 60% of Pakistan’s overseas income comes from cotton and cotton products so its importance is well known for everyone. Climatic changes affect in different ways i.e., temperature, CO_2 concentration, drought, and precipitation.

Excessive temperature exerts a terrible impact on the development of cotton and yield in all stages of plant. It reduces both fibre quantity and quality through impeding normal plant biological processes and pathways. Due to high temperature production can decrease to 50% and in severe conditions these losses can reach up to 70%. As the temperature is continuously increasing in shift so it could be prominent challenge for cotton in next few years. Carbon dioxide concentration in the atmosphere also have increasing trend. Being the C3 nature of cotton plant, it has positive correlation with cotton production but besides that it also has negative impact of heat trapping. It is the major reason of increasing heat stress; therefore, it could also be a serious threat indirectly. Due to disturbed climatic conditions, precipitation cycle and pattern is also disturbed. All this ultimately effects the availability and requirement of water to crop. To tackle all these problems, smart and integrated management is needed. Different agronomic practices like adjustment of sowing period and appropriate usage of resources should be done. Climate resilient cultivars should be introduced to overcome climatic effects. Secondly all those activities should be minimized that causes climate change such as limiting or reducing the emission of heat trapping gases such as CO_2, CH_4 and N_2O. We must move toward energy sources that reduce gaseous emission such as wind energy, water energy, solar energy, and biofuels.

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Evaluation of pneumatic planters for sowing cotton under high density planting system

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Introduction

Cotton is a labour intensive crop and human labour accounts for 55% of the total operational cost and 40% of the total cost of cotton cultivation in India (Reddy 2018). Picking, weeding followed by sowing are the main labour intensive field operations. Unlike several countries where cotton sowing is mechanized, in India it is predominantly sown using human labour, except in the north India where planters like Happy Seeders are adopted. Recently, high density planting system is becoming popular in the country and its adoption requires higher seed rate and additional seed cost. Considering the growing scarcity and increasing cost of human labour, selective mechanization of operations in cotton cultivation is inevitable.

Precision planting is the effective method to raise crop yield. To meet the agricultural requirement of precision planting, various types of precision seed planters have been developed (Sharaby et al. 2019). Different types of planters have been tested for cotton in India and abroad (Kathirvel et al 2005). Their evaluation showed varying degrees of efficiency in terms of speed, singulation, gaps etc. Skips (missing hills) and doubles/multiples could potentially lower seed cotton yield in fields and lower yields by leaving field space unutilized or causing two or more plants to share resources (sunlight, soil moisture, nutrients etc.). A variety of factors- Planters (Planting speed, metering mechanism grading of seed, mismatch between seed plate/orifices to diameter of seeds, efficiency of ground drive wheel and levelling of field, depth of placement), soil (tilth, moisture, salinity/alkalinity, temperature, cropresidues, soil crusting etc.) and seed quality (germination %) affect the number of skips and multiples.

In this study we evaluated the performance of the pneumatic planters for sowing cotton under field conditions for various plant to plant spacing *viz.* 100 mm, 150 mm, 200 mm and 300 mm currently recommended for high density planting in hybrid cotton.

Methodology

The evaluation of planters was done on Vertisols at the Experimental farm of ICAR-Central Institute for Cotton Research, Nagpur, India (N 21˚ 04′, E 79˚ 04′, 306 m above mean sea level)under irrigated and rainfed conditions and on mixed red and black soil at the

Experimental farm of ICAR-Central Institute for Cotton Research (Regional Station), Coimbatore, India(N 11°,E 77°, 427.6 m above mean sea level) under irrigated conditions during the year 2021-22.

Irrigated Vertisols (Nagpur):A field experiment was conducted to evaluate the performance of a three row MaschioGaspardo pneumatic planter at a fixed (90 cm) inter row spacing for sowing of cotton on deep black soils (Vertisol). The planter was evaluated at three within plant to plant spacings viz. 160mm, 200 mm and 300mmusing a 26 hole seed plate. The sowing of BG II hybrid cotton (Cv. Ajeet 155) was done under dry conditions and the field was later irrigated.

Rainfed Vertisols (Nagpur)A field experiment was conducted to evaluate the performance of MaschioGaspardo pneumatic row planter and ICAR-CICR Nagpur, for sowing cotton at a fixed (90 cm) inter row spacing and 30 cm spacing between plants within a rowusing a 26 hole seed plate. BG II hybrid cotton (Cv. Surpass 7576) was sown with the onset of monsoon.

Mixed red and black soils (Coimbatore) At ICAR-CICR RS Coimbatore, PP 400, a four row New Holland Pneumatic Precision Planter was evaluated for planting BG II cotton hybrid (Cv. RCHB 625) on mixed red and black soil. The plant to plant spacing within a row was 150 mm calibrated using a 26 hole seed plate.

In all the three trials the treatments were replicated four times. The observation on the spacing between two adjacent plants at a strip of 5 meter length for each treatment was recorded. This data were used to calculate the following indices of planter performance-

Miss index (M): It is the percentage of spacing greater than 1.5 times the theoretical spacing,

$$I_{miss} = \frac{n_1}{N}$$

Multiple Index (D): It is the percentage of spacing that are less than or equal to half of the theoretical spacing.

$$I_{mult} = \frac{n_2}{N}$$

Quality of feed index (A): It is the percentage of spacing that are more than half, but not more than 1.5 times the theoretical spacing.

$$I_{fq} = 100 - (I_{miss} + I_{mult})$$

Precision in spacing (C): It is a measure of the variability in spacing after accounting for variability due to both multiples and skips.

$$I_p = \frac{S_d}{S}$$

The above indices were calculated using the formulae outlined by Kachmanand Smith (1995).

Table 1: Performance evaluation pneumatic precision planter

Indices	MaschioGaspardo pneumatic three row planter				New Holland pneumatic four row planter
	Vertisols (irrigated) Nagpur			Vertisols (Rainfed) Nagpur	Mixed red and black soils (Irrigated) Coimbatore
	300 mm	200 mm	100 mm	300 mm	150 mm
Miss index % (M)	13.9	21.4	14.8	13.7	20.2
Multiple index % (D)	0.0	1.8	0.0	7.7	1.0
Quality of feed index % (A)	86.1	76.9	85.2	78.7	69.8
Precision in spacing mm (C)	10.6	16.6	24.1	5.1	21.4

Results and discussion

Under irrigated conditions on Vertisols, multiples were not observed in both 300 and 100 mm spacing. The mean miss Index ranged from 13.9% at 300 mm to 21.4 mm at 200 mm plant to plant spacing (Table 1). The quality of feed Index was above 76.9%. Low values of precision in spacing indicate that the overall precision was higher 10.6 mm (or 3.5%) at 300 mm spacing compared to 16.6 mm at 200 mm (or 8.3%) and 24.1 mm (or 16.0%) at 150 mm spacing. In general, smaller values of miss index, multiple index and precision in spacing indicate good performance of the planter.

The evaluation of the planter under rainfed conditions on vertisols at constant inter-plant spacing of 300 mm (Table 1) indicated a mean miss Index of 13.7 %, Multiple index of 7.7% with a high quality of feed index of 78.7% and a precision in spacing of 5.1 mm (1.7%).

The values of quality of feed index in the trials ranged from 69.8 to 86.1% (Table 1) and higher values of quality of feed index indicate better performance of the planter than smaller values. The values of quality of feed index obtained in our study is comparable to the value of 76% obtained with pneumatic planter used for sowing cotton by Senthilkumar et al. 2020. Similarly, smaller values of precision in spacing indicate better performance than larger values. The values for precision in spacing observed in all the three trails of the present investigation were lower than the practical upper limit of 29% suggested by Elmore (2002).

Under irrigated conditions, on mixed red and black soils at Coimbatore (Tamilnadu), the 4 row planter was calibrated for 150 mm inter plant spacing and evaluated. It recorded a Miss Index of 20.2%, a multiple index of of 1.0% and a quality of feed index of 69.8%. The overall precision in spacing was 21.4 mm (14.2%).

Conclusion

In all the three trails, the performance of the pneumatic planter was satisfactory and hence this can be recommended for planting cotton under HDPS where close planting of seeds is labour intensive and time consuming. Moreover, since single seed is delivered at each point, no seed is wasted and thinning operation is eliminated, thus saving seed and labour.

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Sowing with Pneumatic planter on rainfed Vertisol

Germinated seedlings of Pneumatic planter sown cotton

Sowing with Pneumatic planter on Alfisols

Seedling emergence on Alfisols

¿Qué es el INTA?

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"Spanish version"

El Instituto Nacional de Tecnología Agropecuaria es un organismo de vanguardia en Argentina, líder del escenario tecnológico agropecuario, alimentario y agroindustrial. Funciona de manera descentralizada con autarquía operativa y financiera, y depende funcionalmente del Ministerio de Agroindustria. Creado en 1956, desde entonces, desarrolla innovaciones tanto en investigación como en extensión, en las distintas cadenas productivas de valor, regiones y territorios, para mejorar la competitividad, el desarrollo rural sustentable del país y las condiciones de vida de la familia rural.

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En Santa Fe, contamos con 3 estaciones experimentales, una de ellas se encuentra en el Norte de la provincia y se denomina Estación Experimental Agropecuaria Reconquista. En esta se llevan adelante investigaciones relacionadas a la producción animal, a los recursos naturales, a la producción vegetal (algodón, trigo, soja, maíz, pasturas, forrajes, producciones intensivas, otros), al desarrollo rural, a los procesos agroindustriales y numerosas temáticas vinculadas al desarrollo territorial, con vinculación publico privado tanto regional, nacional como internacional.

What is INTA Argentina?

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"English version"

The National Institute of Agricultural Technology is a vanguard organization in Argentina, leader in the agricultural, food and agro-industrial technological scenario. It works in a decentralized manner with operational and financial autarky, and functionally depends on the Ministry of Agroindustry. Created in 1956, since then, it has developed innovations in both research and extension, in the different productive value chains, regions and territories, to improve competitiveness, the country's sustainable rural development and the living conditions of rural families.

What is INTA's Mission?

Promote innovation and contribute to the sustainable development of a competitive, inclusive, equitable, and environment-friendly agricultural, food and agro-industrial, through research, extension, technology development, contribution to the formulation of public policies, and articulation and national and international cooperation. international.

The values and principles that the Institution prioritizes and considers vital for the achievement of strategic goals are: Commitment to national development, through human and social development. From its specific role, the institution is committed to promoting scientific, technological, economic, social and cultural development. Commitment to caring for the environment. The Institution contributes to the search for a balance between productive goals and environmental care by developing sustainable socio-productive technologies and models. Participation, regionalization, decentralization and integration. In all areas, it seeks to expand the spaces for integration and active participation of all agents and actors with a regional and decentralized vision. Innovative and entrepreneurial behavior. It is manifested in the permanent predisposition to learning, cooperation and articulation, to the search for improvements and opportunities in knowledge, and in its application for the design of socio-technical solutions. continuous improvement. Search for excellence in institutional tasks and processes. Empathy and openness. Respect for diversity, seeking consensus and the integration of different perspectives. Service vocation. The commitment of INTA agents to the community and the institution acquires social meaning based on the recognition of the importance of the public function that is implemented from the National State and is a source of professional and civic pride. Sense of belonging. This value is a fundamental asset of the Institution. It refers to the strong identification that the institution generates in its members. Transparency. Accessibility and clarity in actions and in accountability to society.

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In Santa Fe, we have 3 experimental stations, one of which is located in the north of the province and is called the Reconquista Agricultural Experimental Station. In this, research and development are related to animal production, natural resources, plant production (cotton, wheat, soybeans, corn, pastures, forages, intensive productions, others), rural development, agro-industrial processes and numerous themes related to territorial development, with regional, national and international public-private links.