Crop yields will need to increase by 70 per cent to meet the needs of an expanding global human population. Plant breeders at Texas A&M University are contributing to this worldwide effort through research and education.
Developing innovations in agriculture

Professor Wayne Smith has dedicated his career to studying and improving agriculture. Here, he talks about the changing face of farming, how this interest developed and the importance of education and outreach.

To start, could you introduce the plant breeding programme at Texas A&M?

Texas A&M AgriLife Research employs 24 plant breeders whose primary objectives are the development of improved cultivars or enhancement of desirable crop plant traits. They conduct breeding and genetic improvement on 20 crops: sugar cane, energy cane, rice, clover, turfgrass, cotton, corn, peanut, grain sorghum, bioenergy sorghum, wheat, oat, perennial grasses, cowpea, peach, rose, potato, tomato, pepper and melon.

Do these researchers share a collective mission?

14 of these scientists are located on the campus of Texas A&M University at College Station, while the other 10 work at Texas A&M AgriLife Research and Extension Centers across the state. Specific research or breeding objectives vary, but achieving a high yield is always at the top of the list. Examples of our other objectives include: reducing the chill requirement, ie. hours between 0 °C and 7 °C before spring growth, thus extending the geographic range of peach production; improving the yarn-making quality of upland cotton; exploring biotic and abiotic stress resistance; improving the gluten content of wheat for bread making quality; improving protein content; making ornamental flowers more colourful; and improving the trafficability of turfgrasses.

What education and research activities are available to those looking to pursue a career in this field?

Texas A&M University offers graduate degrees in plant breeding as well as in related areas such as genetics and molecular and environmental plant sciences. Graduates find career opportunities in private industry, such as cultivar development companies; the public sector, such as universities and government agencies; and in NGOs around the world.

How did you become interested in plant research? What guided your career progression?

I grew up on a small row crop farm in Alabama, so the desire to have a professional career in agriculture was natural. After receiving my Bachelor’s and Master’s degrees in general agronomy I wanted to work in triticale, and thus began a PhD in Agronomy with Dr Vern Reich, small grains breeder at the University of Tennessee. I soon became involved with, and enthusiastic about, plant breeding and subsequently redirected my graduate career in that direction. It was a wise choice and resulted in an extremely rewarding and satisfying career.

Where do your practices fall within the historic context of crop farming? How have the breeding priorities of farmers changed?

Plant breeding priorities have always been led by yield potential. Since humankind first adopted farming, the ‘type’ of plants grown by farmers has always been dominated by the goal of achieving higher yield per unit land area. Initially, the aim of this was to return more calories in the food gathered than was required to harvest them, whereas today yield potential is paramount to the economic survival of farming operations, as well as feeding an expanding global population. In ornamental and horticultural crops, size of fruit or colour and longevity of flowering are leading priorities. One major change in breeding priorities in agronomic crops would be the discovery of hybrid vigour. At the turn of the 20th Century, no one grew hybrid maize and now almost everyone, especially in developed countries, produces hybrid maize and grain sorghum. A more recent shift in breeding priorities has seen a rise in attempts to develop more nutritious crops, especially in horticultural crops, but also in agriculture in general.

How is science-based evidence being used to advise policy makers and the agriculture and horticulture communities?

The leadership at Texas A&M AgriLife Research networks with local, state and national leaders, thus ensuring that policy makers are aware of the scientific breakthroughs within the system. The tripartite structure of the Land Grant University is designed to move discovered knowledge, such as information which relates to the improvement of cultivars, to the classroom and the public at large. In this way, we can play a part in improving the student learning experience and, through Extension activities, transfer up-to-date information to the farming community and general public. This is important in ensuring our policy makers are informed not only by our AgriLife leadership, but also by our producers and consumers through the electoral process.
Genetically improving crops for human benefit

Ongoing efforts at Texas A&M University and Texas A&M AgriLife Research are focused on developing new cultivars for economically important crops, and educating the next generation of breeders.

**IN THE FACE** of a growing world population and the correlative increase in global demands for foodstuffs, efforts are underway at an enormous number of diverse universities, institutes and organisations to make agriculture and farming practices more efficient, sustainable and environmentally friendly. The ultimate goal is to increase crop yields, which will result in a greater quantity of food being produced per area of land farmed. Within this framework, studies aim to find methods of reducing the production costs associated with farming, as well as increasing the overall quality of crops and improving their resistance to biotic and abiotic stress.

Amongst the leaders in this advancing field is the Department of Soil and Crop Sciences at Texas A&M University and at Texas A&M AgriLife Research – Texas’ premier research agency in agriculture, natural resources and life sciences. Their studies, part-led by Dr Wayne Smith, Professor and Associate Head within the Department, are committed to exploring the development of improved cultivars for Texas’ main agronomic and horticultural crops, whilst ensuring an ongoing dedication to expounding the basic sciences of genetics and genomics. By carrying out hundreds of distinct projects encompassing a huge range of scientific disciplines, the researchers hope that their studies can result in both life-sustaining and industry-changing developments not only throughout Texas, but around the world.

**WHEAT**

One such crop, wheat – of which Texas is the ninth largest producing state in the US – is harvested on around 1.4 million hectares a year at a cash value of US $650 million to the farmers and an overall contribution to the State’s economy exceeding $1 billion. Texas A&M and AgriLife’s wheat project is, therefore, both an economically and socially important aspect of the work they carry out. Led by Drs Amir Ibrahim and Jackie Rudd, both of whom are experts in small grain production, the subgroup’s aim is to increase the yield of wheat whilst ensuring that the crops’ excellent bread-making qualities are upheld in the hard red winter wheat cultivars, and that the outstanding baking qualities are maintained in the soft wheat cultivars.

**COTTON**

Alongside the group’s work on wheat, there is also substantial effort being put into improving the farming of cotton – Texas’ number one agronomic crop. With around 2 million hectares planted each year, Texas A&M AgriLife Research is eager to develop genotypes which can lead to an increase in industrially desirable traits. The group can then provide other cotton breeders.

**GOVERNMENTAL BACKING**

Following the lead of a number of European countries, the US Government made the decision in 1970 to introduce the Plant Variety Protection Act – updated in 1994 – which protects the intellectual property of individuals and institutions involved in sexually reproduced crop species. As these legal rights continued to improve via a series of rulings by the US court, the patenting of cultivars – plants or grouping of plants selected for their desirable characteristics – continued, providing private companies and institutions such as Texas A&M with a significant boost in their attempts to accommodate the increased global demand for crops.

© Li Zhang, Texas A&M AgriLife

Dr William (Bill) Rooney, Professor, AgriLife Research Fellow and Sorghum Breeder with Texas A&M University and Texas A&M AgriLife Research, attaching selfing bags to insure self-pollination in his grain sorghum breeding nursery.

www.researchmedia.eu
INTELLIGENCE

DEVELOPMENT OF GENETICALLY IMPROVED CROPS

OBJECTIVES

Genetic improvement of food, feed, fibre, bioenergy and greenspace plant species for the benefit of humankind.

KEY COLLABORATORS

Faculty involved in plant improvement programmes at Texas A&M include plant breeders, geneticists, molecular geneticists, plant pathologists, entomologists and economists.

FUNDING

State of Texas, commodity groups, federal hatch appropriations, competitive grants, private industry, endowments

CONTACT

Professor Wayne Smith
Associate Department Head
Department of Soil and Crop Sciences
217 Heep Center
Texas A&M University 2474
College Station
Texas 77843-2474
USA
T +1 979 450 3451
E cwsmith@tamu.edu

WAYNE SMITH is a Professor, Associate Department Head and Plant Breeder in the Soil and Crop Sciences Department at Texas A&M University. He teaches three courses and has directed 37 graduate students. Smith has led the development of a distance MS, PhD and continuing education programme in plant breeding at Texas A&M University. His research interests revolve around cotton fibre quality improvement. He has released 124 improved germplasm lines and four cultivars, and has authored or co-authored 99 refereed journal articles and 228 other research publications. He has written one textbook on crop production, co-edited four crop monographs and authored/co-authored 11 book chapters. Smith is active in the American Society of Agronomy, Crop Science Society of America, the Beltwide Cotton Conferences and the National Association of Plant Breeders.

with genotypes that can be used as parents for the development of new cultivars.

The cotton subgroup, including Smith and colleagues Drs Steve Hague and Jane Dever, is seeking to improve fibre quality, drought tolerance and disease resistance, and has recently succeeded in developing genotypes with increased fibre length and strength that can be made into ring-spun yarn 25 per cent stronger than that made from most currently grown cultivars. The research team has also achieved increased resistance to Verticillium wilt, one of the most prevalent vascular cotton diseases within northern Texas.

Sorghum

Historically, research carried out at Texas A&M University has also made an enormous impact on the growth of sorghum, which is used worldwide for food, fodder, alcoholic beverages and biofuels. In the early 1950s, Texas A&M AgriLife Research scientists discovered an innovative and efficient way of producing hybrid seeds of the grain, and today every hectare of grain sorghum within the US is a hybrid. “About 75 per cent of the grain sorghum hybrids grown in the US are derived from genetic material developed at Texas A&M,” Smith enthuses. “And 50 per cent of sorghum hybrids worldwide have genetics developed at Texas A&M AgriLife Research.” The agency continues its work to improve the production of sorghum under the leadership of Drs Bill Rooney and Gary Peterson.

Peaches

In addition to these efforts, Texas A&M AgriLife Research scientist Dr David Byrne – a recipient of the National Peach Council’s Carroll R Miller Award – is exploring ways to grow peaches more effectively. Byrne, who is an expert on stone fruit and roses, received the award for introducing four cultivars of peach to new geographical areas. “The releases are part of several decade-long projects in which I have been developing a range of stone fruit types adapted to the warm winter regions of the world,” Byrne explains. He is now working to release a number of flat and yellow peaches and nectarines to the same regions. With the assistance of colleagues, Byrne has also carried out some fascinating research into the origin of peach germplasm, and documented the health benefits of consuming both peaches and plums.

Peanuts

Within Texas A&M AgriLife Research, a fifth research strand is being led by breeders Drs Michael Baring, Charles Simpson and Mark Burrow, who over the last decade have released a number of improved peanut cultivars. Texas is the second largest peanut producing state in the US, and the peanut subgroup has developed nine new cultivars since 2002, all of which demonstrate improved oleic content for human health purposes and exhibit good levels of disease resistance. “We even developed the first root-knot nematode resistant peanut cultivar grown commercially anywhere in the US,” Smith recalls.

EDUCATION AND OUTREACH PROGRAMMES

Inextricably linked to their pioneering research, Texas A&M is dedicated to the promotion of student engagement and public outreach projects. “In a country lacking the highly qualified professionals needed for the growing number of science, technology, engineering and mathematics careers this issue requires a lengthy, detailed and complex discourse,” Smith argues. As part of its efforts to train the next generation of agriculturalists, the institution offers students a wide range of traditional and more specialised majors and encourages them to study abroad, undertake internships and publish their findings in scientific journals.

The university is also the first in the US to offer a PhD in Plant Breeding via distance learning. Moreover, the Extension component of Texas A&M is proactive in distributing the institution’s findings both to industry partners and to the wider public, improving both farming techniques and the understanding of food production and nutrition. It is through this unique combination of research and education that Texas A&M is expected not only to generate socially, economically and environmentally significant discoveries and developments, but to ensure that its cutting-edge work enjoys the dissemination and uptake it deserves, leading to concrete improvements in the farming of a diverse range of crucial crops.