Why was this project on sustainable livestock production, biofuels and health established?

**VF:** There are major issues in population growth, food, health and energy in India and we recognise that there is a correlation between these concerns and global challenges in sustainable food and energy demand.

**The Green Revolution had a lasting impact on India. Has there been further progress on improved yields and production methods in recent years?**

**VF&KZ:** There has been progress but the rate of productivity gain is declining and failing to keep up with the anticipated rate of growth in food demand.

A recent report in *Nature* revealed that increased consumption of meat in India and China is negating reductions elsewhere. Can this trend be managed sustainably?

**VF&KZ:** The vast majority of the world’s population is increasing its consumption of animal products (including meat, milk and eggs) as their income rises. Developing sustainable production systems to meet this growing demand is a global challenge and a major motivation for this project.

**Does the policy in India favour renewable energies?**

**VF&KZ:** India is making massive investments in conventional electricity and other energy systems in an effort to meet the rapid expansion of energy demand. It is also making investments in sustainable and renewable energy systems. In fact, North Carolina State University (NCSU) alumnus and climate change Nobel Prize winner Rajendra Pachauri leads the The Energy and Resources Institute (TERI) and TERI University in India, which focus on sustainable development in India.

How was the partnership with NCSU initiated; and how do you engage your students in these topics of international importance?

**VF&KZ:** Several NCSU faculties with an interest in India applied for, and were awarded, a US Department of Agriculture International Science and Education (USDA ISE) Competitive Grants Program to facilitate scholarly exchange.

Products of the USDA ISE grant and related projects, such as the South Asia programme at NCSU, are collaborative courses taught in India and at NCSU to expose students to these areas of science. Students from India who graduated from these courses have since visited the US and likewise US students have visited India to learn firsthand about the situation and its associated issues.

**Students and faculty have taken part in the exchange programmes. How have they transferred their knowledge?**

**VF&KZ:** Students are pursuing graduate degrees to increase their expertise and capacity to create positive change on these issues. Meanwhile, faculty are continuing their mission to develop new collaborative courses and research proposals (such as the Obama Singh 21st Century Knowledge Initiative – OSI) in an effort to expand the impact of the newly formed relationships. This project remains a tiny step forward in comparison to the scale of the challenges faced. ICAR has the capacity to greatly expand the breadth and effect of these initiatives.

What type of extension projects are you engaged in? Is it easy, or indeed feasible, to replicate the programmes of North Carolina in India?

**VF&KZ:** Extension systems in the US and North Carolina are part of the integrated land grant system of research, education, extension and rural development that is unmatched anywhere in the world. Under the Indian Council of Agricultural Research (ICAR), India has the largest network of agricultural universities and agricultural research institutes in the world, including front-line extension offices such as Krishi Vigyan Kendras (KVKs). Many of these current agricultural institutions were established during the Green Revolution.

A challenge for ICAR and Indian agriculture is to rapidly expand the capacity of expert support networks in India to meet the exponential growth in demand for agricultural products.

**Would you recommend and encourage international partnerships for the improvement of agriculture?**

**VF&KZ:** The global grand challenges in sustainable food and energy production will not be met successfully without international collaborative efforts. ICAR officials are reaching out to countries around the world.

What do you envision for the future of Indian food, biofuel production and sustainable development?

**VF&KZ:** With appropriate investment in integrated research, education, extension and rural development, we envision a second green (and white) revolution in India with rapid increases in productivity. We also anticipate a rapidly growing international trade sector in India around agricultural products, food and renewable energy as well as all the goods and services needed to support those primary sectors.
A sustainable future

A scholarly exchange project between North Carolina State University and the Indian Council of Agricultural Research seeks to address challenges facing today’s agriculture and develop mutually sustainable solutions.

According to the UN, the world population, currently estimated at over 7.2 billion, is expected to rise by almost 1 billion by 2025. Of this growth, India is expected to grow faster than China and surpass their current 1.4 billion citizens to become the world’s largest nation. As a rapidly developing and expanding country, it is apparent that India will require sensible investments in infrastructure, healthcare, industry and services to support its inhabitants sustainably; and in a global economy, changes in India will reverberate the world over. A partnership between North Carolina State University (NCSU), USA, and the Indian Council of Agricultural Research (ICAR – one of the largest agricultural development and research systems in the world) was established to undertake a crucially important research project to address global grand challenges in food production, food insecurity, renewable energy production, declining natural resources and the prevalence of disease. The project partners focused on India’s highly diverse agricultural system, its most fundamental and most important industry, to learn how it can be improved to support sustainable development.

Funded by a US Department of Agriculture International Science and Education (USDA ISE) grant, the scholarly exchange project titled ‘Sustainable livestock production practices through stakeholder partnerships: lessons with India’ and led by Drs Vivek Fellner and Kelly Zering from NCSU, sought to address these issues by building the discourse between academic, government and industry stakeholders to bolster competitive research and educational prowess.

Overall aims

Fellner and Zering combined their knowledge in dairy science, farm management and biofuels economics to help structure the programme in both countries. As educational establishments, public health systems and rural development in India are at a critical juncture, the exchange programme allowed students to provide useful insight on how to design models for educational interactions for sustainable growth. Participants also identified challenges and opportunities in optimising production practices to enhance dairy productivity and animal health and in addressing renewable energy issues.

Several interrelated economic concerns were explored through the programme because, while India has experienced dramatic economic growth over the past several decades, responding to global grand challenges in the future is a daunting prospect – there is less land available for agriculture, diminishing reserves of fossil fuel and water, increasing pressure on production from population and increased prevalence of disease.

Realising India’s potential

Since the 1940s, India has experienced significant growth in agricultural production through advances in irrigation, the modernisation of management techniques and the increased availability of fertilisers and pesticides. One of the main improvements to India’s agricultural outlook was the introduction of high yielding varieties of seed, brought to the nation by American agronomist and Green Revolution visionary Norman Borlaug. These reformations improved the lives of rural inhabitants throughout India and Borlaug was credited with saving over 1 billion people from starvation.

The White Revolution followed shortly after in 1970 – so-called because of a dairy development programme initiated by the National Dairy Development Board (NDDB) which made India a self-sufficient milk producer. “There is a definite link between the secure supply of food, animal health and the health of rural residents,” explains Fellner. “This is particularly obvious in the influence of dairy in India and the reliance on dairy as a major food among the poor and wealthy.” Zering expounds: “Restricted supplies of feed and fodder for cattle can slow further increase in milk yield and cause serious issues for this cornerstone of India’s diet and agriculture, affecting the income and health of rural families.”

Global concerns

Dairy nutrition was one of the global challenges addressed in the exchange project. At present, poor nutrition contributes to more than half of the nearly 11 million child (under five) deaths that occur each year. India has made progress toward reducing poverty and has the potential to fulfill the need to improve nutrition and thereby lead in achieving global Millennium Development Goals. This can only occur with greater agricultural productivity, food processing, access to markets and sustainable practices that seek first to provide food to meet the doubling in demand from its own citizens by 2030.

Renewable energy has proven to be a double-edged sword for India. While it has the...
potential to reduce fossil fuel consumption and greenhouse gas emissions, renewable energy systems that divert agricultural land to monocultures of switchgrass or corn, for instance, can undermine food supply. To meet renewable fuel obligations many countries have invested heavily in fuel crops resulting in the diversion of resources in India such as water, fertiliser, energy and agricultural land away from producing food for the domestic population.

Economic growth, as previously mentioned, is shifting the influence of India in global affairs such that it is now greater than ever before. So, even though there are many unsustainable practices currently in use, India is striving to change its future for the better by investing heavily in education to increase opportunities of the present generation while, at the same time, ensuring the country’s poorest have access to food as demonstrated by the recent National Food Security Bill.

This project allowed NCSU experts to visit 11 different agricultural regions in India. Exchange between experts from NCSU and India allowed exploration of many issues in great depth. Scientists from India travelled to NCSU to engage in research to study alternative ways to increase agricultural productivity. Student groups travelled to India and visited research institutes, NGOs and government organisations. NCSU engaged with The Energy and Resources Institute (TERI) University via the John D and Catherine T MacArthur Foundation Project and NCSU faculty delivered a course module on Science and Technology for Global Sustainability (STS) at TERI University in 2010. In 2011 and 2014, the same course was offered at NCSU.

NCSU hosted several speakers from India in a three-day forum to engage experts on challenges faced in India in agricultural development and socioeconomic impacts of growth. “NCSU Chancellor Randy Woodson spoke at a national meeting in India attended by the President of India and a large audience of the leadership of Indian agriculture. Chancellor Woodson spoke about our mutual interest in improving agricultural productivity and educational interaction,” recalls Fellner. Both Fellner and Zering are invited speakers at the Global Animal Nutrition Conference (GLANCE) to be hosted by ICAR in Bangalore.

EDUCATING FUTURE GENERATIONS

Fellner and Zering are positive that partnerships such as this will continue to educate others about sustainable growth and the tools needed to make an impact: “ICAR officials are working with both developed and less developed countries around the world to establish relationships and extend their agricultural expertise,” they elaborate. “We strongly believe that future trade relationships as well as scholarly and research relationships will grow out of current interactions.”

The success of the project, embodied in the memorandum of understanding between NCSU and ICAR, is the creation of a formal basis for ongoing student and faculty exchange and collaboration. An immediate product of this collaboration was an Obama Singh 21st Century Knowledge Initiative (OSI) proposal to strengthen joint programmes between American and Indian higher education institutions.

Future collaborative projects in research, education and training in agricultural and sustainable growth are already in the pipeline. The team is now focusing on an assessment of the current situation in animal and human health to support progress on the grand challenges. Maintaining a fluid transfer of knowledge and practical experience in disparate settings enabled through the exchange programme will aid India’s rapid transition to a developed nation that not only invests in its physical infrastructure but also nurtures its intellectual capacity and relationships with international partners.

INTelligence

SUSTAINABLE LIVESTOCK PRODUCTION PRACTICES, BIOFUELS AND HEALTH: LESSONS WITH INDIA

OBJECTIVES

• To engage stakeholders in North Carolina and India
• To identify avenues of collaborative research and extension across the two countries
• To promote student and faculty exchange and facilitate information transfer

KEY COLLABORATORS

North Carolina State University: Drs Prema Arasu; Maria Correa; Isabel Gimeno; Ratna Sharma-Shippava; Paul Bergey; Kelly Zering; Vivek Fellner

Indian Council of Agricultural Research (ICAR): Dr S Ayyappan, Secretary, Department of Agricultural Research and Education (DARE) and Director General of ICAR; Dr KML Pathak, Deputy Director General (Animal Science); Dr CS Prasad, Director, National Institute of Animal Nutrition and Physiology (NIANP)

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VIVEK FELLNER is a ruminant nutritionist with a focus on microbial ecology and energetics of fermentation. He is keenly interested in enhancing nutrient use and minimising waste and negative impacts on the environment. He has presented at international conferences, and served on teams travelling overseas to evaluate academic and research opportunities for global sustainable development.

KELLY ZERING is an agricultural economist with a focus on animal agriculture and biofuels systems. His current research and extension initiatives centre on the economics of technological innovation and advanced management to improve human welfare, conserve resources and improve the environment. He has presented at international conferences, travelled internationally to consult with animal agriculturalists and assessed agricultural research, extension and education programmes.