

University of Kentucky Alumni Association

# KENTUCKY

## Alumni

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**Hemp: More than just fiber**  
UK research will optimize production

# Hemp:

*More than just fiber*

## UK research will help optimize production

By Linda Perry

What if Kentucky could once again be a leading producer of a crop that is experiencing increasing market demand and can be processed into thousands of products and useful applications? You know, like the millions of dollars that Canada reaps with its exports of hemp seed and products to the United States. The notion of the monetary benefits of producing hemp is raising the interest of farmers and other individuals looking for a way to capitalize on a plant that has had a history of flourishing in the Commonwealth.

“It’s not just about fiber,” said Adam Watson, hemp coordinator for the Kentucky Department of Agriculture (KDA). “That’s what’s so promising about hemp — it’s not the same product that it was some 70 years ago. It’s got an even greater potential today.”

However, the possible returns on the crop are currently elusive. “We will likely have more farmers lose money on hemp than make a profit this year,” he says. “It’s entirely understandable given that the crop is completely unknown to our producers. We’ll quickly see that trend reverse as the best production methods and varieties for Kentucky are established.”

Industrial hemp research at the University of Kentucky is moving along in its second year. The UK Department of Plant and Soil Sciences (PSS) and the Kentucky Tobacco Research and Development Center (KTRDC) are joint participants in the KDA Industrial Hemp Pilot Research Program. UKAg agronomists David Williams (PSS) and Rich Mundell (KTRDC) are leading the research efforts investigating agronomic parameters affecting field-scale production of industrial hemp. The projects are being conducted under the guidance of KDA.

While the first year’s pilot project was limited to varieties used for fiber production, this year’s research trials include hemp varieties used for the production of fiber, grains and cannabinoids. Cannabinoids, such as hemp-based cannabidiol (CBD), may be used in food and dietary supplements for consumer health and wellness benefits.

“Our work has expanded greatly this year to include all three harvestable components of hemp,” Williams says. “We are hoping to optimize grower profitability through these small plot studies.”

Research projects include comparing the fiber quality of three varieties of hemp. The varieties will be compared to each other as well as flax and kenaf, other fiber plants. The project will look at two harvest methods and three harvest timings when the plants are at different maturities.



Other research includes two separate hemp variety trials for fiber and grain production, herbicide tolerance trial for hemp used for grain production and a row spacing trial geared toward fiber production. Specific projects are conducted in conjunction with researchers at Murray State University (MSU), Western Kentucky University (WKU) and Eastern Kentucky University (EKU).

Mundell says hemp research is appropriate for the Kentucky Tobacco Research and Development Center, whose objective is to find new uses for tobacco, but also encourage and facilitate the development of new crop opportunities for Kentucky agriculture. “This fits our mission,” he says. “When hemp came along, we realized it was a novel crop that we could work on to see if it is something Kentucky farmers could grow in place of tobacco.”

Leah Black is a graduate student looking at using the tobacco production model as a system to produce CBD. She is investigating whether unpollinated populations of female hemp plants produce more cannabinoids, and she will conduct a yield test based on direct seeding and various transplant densities using a tobacco setter.

Mundell says transplants will be grown in the green house and set in the field using the same equipment that a tobacco



**UK Biosystems & Agricultural Engineering and the Agricultural Machine Research Laboratory developed a prototype hemp flower harvester used to collect the hemp varieties for CBD production research.**

farmer already uses. “If specified spacing proves to be a good method of producing CBD, then Kentucky farmers would have an advantage in that we already have the equipment and the know-how to grow and set transplants. Furthermore, if it turns out that CBD is a labor-intensive crop similar to tobacco, with hand harvesting and hanging in a barn to cure, then that would be something else Kentucky farmers are also already accustomed to.”

Mundell says that some people think CBD could bring a profit per acre similar to tobacco. It could be exactly what Kentucky has been looking for as an alternative crop to tobacco. Also, hemp used in crop rotation could be beneficial in lowering disease and weed pressure, if established properly.

“Kentucky definitely has the jump on most other places,” says Mundell. In addition to the research that UK is conducting, he says the state is in a good position partially because of hemp processors — for example, Sunstrand LLC — which has come to Kentucky to take a chance on the potential industry here. “Sunstrand, which specialized in bamboo fiber processing in Montana, moved to Kentucky in 2014 to set up a small pilot-scale facility in Louisville. The company works on developing composites using natural fibers for strength rather than man-made fibers. From what the owner tells us, this is something

the automobile industry is interested in because natural fiber composites are lighter in weight, have high strength and are more green for the environment.”

This year’s research projects are funded by several corporations, with administrative support from KDA, and also involve collaborative work with several faculty members and graduate student Black. In addition to Williams and Mundell, this includes David Hildebrand, professor in Plant and Soil Sciences, who is investigating the molecular genetics of hemp oil composition. Ling Yuan, also a professor in Plant and Soil Sciences, is studying the protocols for genetic modification of industrial hemp. Their research is made possible through grants from the Kentucky Science and Engineering Foundation.

### **History of hemp in Kentucky**

The KDA website says that because there is no commercial industrial hemp production in the United States, the U.S. market is entirely dependent on imports, both as finished hemp-containing products and as ingredients for use in further processing. More than 30 nations grow industrial hemp as an agricultural commodity. The United States is the only industrialized nation that does not allow industrial hemp

production. Some industry estimates report that U.S. retail sales of all hemp-based products may exceed \$300 million per year, although that number might be optimistic.

At the heart of the matter: it is legal to manufacture and sell hemp-based products in the United States, but illegal to grow it.

Fabrics, paper, carpeting, construction materials, foods, beverages, auto parts, cosmetics, animal bedding, etc. — the list of products containing hemp is extensive today. This is very different from the results of the first recorded Kentucky hemp product that was grown on Clark's Run Creek in Danville in 1775. Settlers in the Commonwealth did use hemp for textile production, but according to the Kentucky Historical Society, the largest use of hemp was to create rope and woven bagging that bundled cotton bales. The U.S. Navy bought Kentucky's rope for ships' rigging, and factories in Central Kentucky turned out the woven bagging for farmers. Pants, known as Kentucky jeans, were also manufactured.

Kentucky's climate and soil are excellent for producing hemp, particularly in what is known as the bluegrass area. Industrial hemp was a viable economic engine, with Kentucky leading the nation into the early 20th century.

So what happened?

According to an article in the Lexington Herald-Leader, manufacturing changed after the Civil War. Ship riggings were now made of metal, cotton was baled using a technique that didn't need fabric, and new fabrics were used to make jeans. The demand for hemp dwindled and so did the market, although Kentucky was still in the game, producing 90 percent of the hemp in the United States.

During World War II, the government encouraged the growing of hemp to replace the hemp and other natural plant fibers, such as jute, that were no longer coming to this country from the Philippines and Russia. So production kicked up for a while, until after the war.

Everything changed in the 1970s when all cannabis varieties, including hemp, were designated Schedule 1 substances under the federal Controlled Substances Act. Thrust into the same category as heroin and marijuana, this meant that without a license from the Drug Enforcement Administration, people were breaking the law by growing hemp. U.S. production became nonexistent.

After almost 45 years, the Agricultural Act of 2014 passed by Congress included a provision that allowed colleges and state departments of agriculture to grow and conduct research on hemp in states where it is legal. Cannabis varieties may be legitimately grown in Kentucky under the auspices of a university research project or the KDA.

Watson says the KDA has 127 participants in its program, including eight universities. These include farmers and processors — private cooperators who are interested in growing or processing hemp for profit and are engaged in conducting research on behalf of the KDA. Once harvested, the hemp is sent to a processor in Kentucky and sold for use in a variety of products. Farmers collect data for the KDA about the viability of the crop grown in the real-world environments of family farms. Processors submit information about the use of hemp and the subsequent economic data associated with the marketing of hemp products.

Photo: ExploreUK



**An unidentified man beats out hemp seed on the Experiment farm at the Agricultural and Mechanical College of Kentucky in 1901.**

### University of Kentucky research

The agronomists with the UK College of Agriculture, Food and Environment began planting their 2015 hemp research plots in May on the university's Spindletop Research Farm.

"Variety selection is key to optimizing production. That's one of our basic goals — to evaluate many varieties and within that, planting dates for many varieties," says Williams. "Hemp is photosensitive, so the size of the plant — the maximum growth of the plant — is defined by day length and not by temperature or weather or physiological maturity. We would prefer not to have grain crops that are 8-foot tall. So it's important to select a variety that might not grow that large before flowering and then determine the best planting date for optimal grain yields and still manage that plant at half that height at 4-foot tall. On a basic level, that is one of our earliest and most important goals for Kentucky farmers."

Williams says the second goal involves contributing to hemp production for fiber. "Retting hemp is a new experience for everyone in Kentucky, where in other cultures, particularly Europe, it's a well-known process. So we are still learning how to properly ret hemp, which is a 'rotting' of the hemp stalk where the fibers are derived."

Finding the sweet spot that allows the fibers to be easily separated but not rotted too much will be important, he says. "For Kentucky farmers to produce hemp fibers of high quality,

we need to be able to quantify certain aspects of this process and provide good information for farmers. It's not quite as cut and dry as I thought it might be."

Williams said that historically, hemp was processed by hand, a very labor intensive activity. "The mechanical processing of hemp makes retting more important than it used to be. It's imperative that the retting be perfect," he says. "That process is totally dependent on the weather, variety, stem diameter within a variety — so that means seeding rates. There is lots of information that we need to be working on to provide good information for Kentucky farmers."

Tim Stombaugh, Extension professor in Biosystems & Agricultural Engineering, led the effort to develop a design for the prototype hemp flower harvester used to collect the hemp varieties for CBD production research. He collaborated with Will Adams, a senior research engineer in the Agricultural Machine Research Laboratory, as well as other support technicians in the department, to build a harvester almost completely from scratch in a six-week time frame. They borrowed a few components from a combine head, but most of it was fabricated from other parts. The unit attaches to a typical farm tractor.

"An outside company came to us and said they needed a mechanism to harvest the hemp earlier before it goes to seed for use in pharmaceuticals. All they wanted was the top part of the plant where the flower is. The top foot of the plant needed to be cut, gathered and transported somehow. That's what we built," says Stombaugh. "There are different varieties and strains of hemp. Some of it is knee-high and some of it is 12-feet tall. This thing has the flexibility to go low and go high, and that's why we put it on the front of a standard front-end loader."

Stombaugh says there is still tweaking taking place on the mechanism, but overall, he was pleased with the initial result. "We took our best shot at it. Functionally, it worked well," he says.

Mundell says that one of the aspects that sets Kentucky apart from other states is that a Kentucky-based company is now producing certified seed of many of the varieties of hemp that researchers are using. "Kentucky Hemp Seed Research and Development Co., a subsidiary of Atalo Holdings in Winchester, is growing certified seed that is inspected in the field to insure genetic purity," he says. "Having the seed grown in the state will help to avoid paperwork complications that sometimes occur when seed is imported into the country from Europe and Canada."

Atalo will also process the grain, extract oil from the grain and uses the "cake" left over after the oil has been extracted to make other products. UK researchers, in cooperation with Atalo, are also investigating the possibility of making silage out of the hemp that could be utilized as a high-quality forage to feed cattle. "We've chopped some hemp that had just started to form mature grain and packed it into research-scale mini-silos. We're looking at whether hemp that is just starting to form mature grain has the proper moisture content to allow the ensiling process to happen," says Mundell. "After the hemp has been a month in the silo, we will open some of the silos to see if the ensiling process was successful. We'll continue to open new silos each month during the winter months, when a farmer would typically be feeding his cattle, and assess the quality of the silage over time."

Mundell says one of the major responsibilities of university researchers is not to report findings based on anecdotal evidence. "We perform science-based, replicated field trials over several years and in different locations so that we can eliminate the many variables that can affect the performance of a crop. This research will give Kentucky hemp farmers production guidelines based on sound scientific research. For example, we will hope to define what are the best hemp varieties, the best seeding rates and planting methods, and optimal fertilizer rates to apply for hemp grain, fiber and CBD production systems," says Mundell. ■



Photo: Steve Patton, Agricultural Communications Services

## Collaborative efforts

As UK researchers evaluate the yield and fiber quality differences among different harvest times and harvest methods, they are also looking at retting times and retting methods. UKAg is collaborating with researchers at EKU on this project, which is funded by Sunstrand LLC.

The best production method for cannabinoids for pharmaceutical use is being funded by CannaVest Corp.

Funded by Freedom Feed and Seed, UK researchers are manipulating plant growth rates in the greenhouse and the field of hemp used for grain and cannabinoid production. They are studying whether small plants make the harvest simpler and whether they have a yield difference compared to larger plants.

In collaboration with MSU, UK scientists are conducting a variety trial of hemp plants for grain production and UKAg researchers are working with WKU on hemp's tolerance to agricultural herbicides.

Kentucky Hemp Seed Research and Development Co., a subsidiary of Atalo Holdings, donated a significant amount of seed to the 2015 UK hemp research project.

UK's 2015 Kentucky Hemp Field Day generated strong interest in August.



# Pritesh Kumar:

## Medicinal cannabinoid testing, research and development

By Robin Roenker

Pritesh Kumar knows he's in a lucky place. Not many people can say they own their own company, doing exactly the type of work they dreamed of doing, much less just six years following their college graduation.

Kumar received his undergraduate degree in biology from the UK College of Arts & Sciences in 2009 before earning a doctorate in pharmacology and toxicology with a concentration in cannabinoids from the University of Louisville in 2014. He is founder and CEO of PhytoSciences Inc., a firm that hopes to help lead the new wave of medicinal cannabinoid testing, research and development in the United States.

Kumar's work is his passion, and he says he's committed to helping set more rigorous industry standards so that medical applications for cannabis and its derived compounds can be more safely and effectively developed.

Kumar launched PhytoSciences in 2014 with co-founders and fellow UK Department of Biology graduates Brad Biggs '10 AS and Mark Hamann '09 AS. The longtime friends, who met at UK, felt the timing was right to focus their combined skills on what they loved: natural pharmaceutical research and development.

### An "atypical" undergraduate

Though he was born on the west coast, Kumar's family moved to the east coast when he was still young. As he was completing high school and beginning his college search, two things about UK appealed to him.

"When I visited campus, it was so beautiful and student-oriented, and that really attracted me," says Kumar. "But also, I had been looking for a college with a natural products pharmacology division. Investigating potential medical and pharmaceutical applications for natural plant compounds has always been my real passion. I learned about a professor at UK at the time, Dr. Cecile Marczynski, who was doing research and teaching classes in that area, and that was a key reason I decided to enroll at UK."

Kumar also credits Marczynski's class with setting him on his eventual career path. That course is what really caused me to turn my attention to cannabis, and led me eventually to pursue my Ph.D. solely on exploring that plant and its pharmacology," he says.

During his tenure at UK, Kumar says he was thought to be an "atypical" undergraduate by his friends.

Most likely, his friends were picking up on Kumar's uncommonly high determination and drive, both for his studies and in balancing his many part-time jobs.

Eventually, Kumar scored a job washing scientific glassware in Brian Rymond's UK laboratory. While other students might have deemed the work boring or inconsequential, for Kumar it was a learning opportunity. He also worked part-time in Bernard Hennig's laboratory investigating the role nutrition plays in preventing vascular toxicity induced by polychlorinated biphenyls (PCBs).

Before he graduated, Kumar had leveraged that early laboratory exposure into research assistantships with the College of Arts and Sciences Department of Biology and the College of Medicine Department of Pharmacology and Nutritional Sciences.

### The goal: Becoming an industry leader

Kumar draws upon the same untiring drive that defined his undergraduate years to devote himself to not simply advancing the new field of medical cannabis research in America, but *leading* it.

"In one to two years, we plan to become the leading international consulting company in the areas of laboratory development, cannabis extraction methodology, R&D and manufacturing set-ups," he says.

Already, in just one year, PhytoSciences has attracted 31 scientists as consultants, many of them international leaders in specialties ranging from molecular biology, biochemistry and plant botany to laboratory design, drug extraction and formulation chemistry, he says.

While medical cannabis research has been

performed for years in other countries — Israel, especially — in the United States, the field is emerging and plagued by a lack of regulatory standards.

Currently, under U.S. Federal Law, use of cannabis is illegal. At the state level, only four U.S. states plus Washington, District of Columbia, have legalized recreational use of cannabis, and an additional 20 others — not including Kentucky — have legalized the use of medical cannabis. The production of cannabis-based medications does not fall under the guidelines of the Food and Drug Administration (FDA). In states where medical cannabis is legal, currently there are minimal to no mandated standards for its testing, production or quality control.

PhytoSciences hopes to change that.

"Established analytical laboratories where traditional pharmaceuticals are tested and produced will not touch medical cannabis, because it's federally illegal. This invites other start-ups to try to establish laboratories for the production of cannabis-based medicines, even though at times they may not have the knowledge, operational expertise or proper equipment to run a pharmaceutical laboratory," Kumar explains.

"So we're helping our clients set up laboratories that exceed FDA-compliance standards, since those are the best standards we have to use as a basis," Kumar says. "And we ensure that we go above and beyond those."

PhytoSciences consultants help their clients develop proper testing protocols, establish quality control procedures and identify the proper equipment and staffing necessary to begin to test and produce cannabis-based products, ensuring their products are safe, efficacious and standardized.

The company has consulted on 15 laboratories and three manufacturing sites in Colorado, Connecticut, New York and in Canada, where the use of medical cannabis is legal nationwide.

"We don't take on every project that approaches us. We personally like to work

in jurisdictions that have well-written, tightly-regulated legislative restrictions on the production of cannabis products. That ensures that patients aren't receiving cannabis-based medications that could have mold or other contamination in them," Kumar says.

"These cannabis-based products are medications, and the way we think about it is that they should be undergoing the same testing that is required for any other medication that is on the market," he adds.

Recently, PhytoSciences began consulting with several companies in Kentucky that hope to establish extraction and manufacturing laboratories in order to produce medications from extracted cannabidiol, or CBD, a cannabinoid present in both cannabis and hemp.

"Right now, in this industry, there are no regulations on the quality of these products," says Brad Biggs, PhytoSciences's quality control and extractions specialist. "If either a laboratory or a cultivator wants to know the concentration of cannabinoids in their product or to determine if it's contaminated, there are no standard regulations or protocols in place for them to do that. We can come in, help them set up their laboratories and teach them the appropriate procedures for analysis."

Fellow co-founder Mark Hamann has enjoyed the chance to not only work with two of his closest friends, but to do it within a company that is setting lofty goals.

"All of us wanted to find a way of putting our interests and talents into something that would be able to help others, which this work does, both in terms

of advancing science and the medical field, as well as boosting the economies where our clients are based," says Hamann, who is a sales associate for PhytoSciences.

In three years' time, Kumar says he hopes to expand PhytoSciences' global consulting presence into Europe, South America and Asia as the markets for cannabis-based products emerge there. And in four to six years, he hopes to build the first cannabinoid institute for research and development in the United States.

"Israel has long been the 'mecca' for leading-edge cannabinoid research. There is no reason that the United States should not take more of a leadership role in this type of research," Kumar says. "My vision is to bring all the top-talented scientists in this field under one institute, here in the U.S., where we can vigorously research this plant and its therapeutic potential from a basic research standpoint and then translate this research by conducting clinical trials. We will eventually be in the position to give patients the answers they are seeking and to provide regulators with the data they require to understand the potential medical value of this plant."

### A quick biology lesson

"Cannabinoid" is a term that describes the chemical compounds found naturally within the cannabis plant. The human body has two types of so-called "cannabinoid receptors," which react with and respond to these compounds. The cannabinoid receptor 1, or CB1, exists within the body's central nervous system, brain and spinal cord. It's this receptor that

is responsible for marijuana's psychoactive effects. Kumar's own laboratory research with cannabis has focused on what's known as the cannabinoid receptor 2, or CB2, which exists within the immune system within the body's B cells and T cells.

"There's much less known about CB2 than CB1. I was interested in CB2 primarily because you can develop therapeutic agents that act on CB2 that do not get the patient high, for example," Kumar explains. In Kentucky, Kumar's research has focused on synthetic cannabis compounds, since testing using real cannabis plants is not legal in the Commonwealth.

Preliminary research has suggested that cannabis compounds can affect CB2 to reduce arthritic and cardiovascular inflammation, among other beneficial outcomes. Cannabis-based therapeutics have also been shown to reduce the frequency and severity of seizures in some pediatric patients.

"For me, where my passion is, is getting down to the mechanistic nuts and bolts of *why* there is this cause and effect — to really examine and try to find out what is going on at a molecular level when the cannabinoids react with these receptors in the body," Kumar says.

"There are still so many questions," says Kumar. "We plan to continue inviting different scientists to collaborate with us, so we can keep teasing apart this plant and truly understand its mechanism of action. That's how true science gets done. ■

## Research at UK

There are several research projects in the UK Department of Behavioral Science that focus on cannabinoids.

For example, Shanna Babalonis, assistant professor in behavioral science and UK Center for Drug and Alcohol Research (CDAR), completed a research trial examining the effects of a cannabinoid compound called cannabidiol, or CBD, when consumed in combination with smoked marijuana. The multisite study was to determine if CBD could be explored as a treatment for marijuana dependence.

Results from the trial suggested CBD did not change the physiological, cognitive or subjective effects of marijuana. Babalonis said the study serves as evidence that CBD does not reduce the high caused by smoking marijuana. The study is one of the first to provide evidence CBD does not change marijuana effects and CBD displays low abuse liability.

"There is a great deal of interest in the therapeutic effects of marijuana right now," Babalonis said of CBD. "CBD may be useful for other conditions, but it does

not look like it is an effective treatment for marijuana dependence. However, we are excited to continue to test other cannabinoids to determine if they may be useful in treating drug abuse or other conditions."

The UK CDAR laboratory joined with Columbia University and the Medical University of South Carolina to collect laboratory data for the study.

Sharon Walsh, professor of behavioral science and director of CDAR, is working on several additional research projects funded by the National Institute on Drug Abuse, including one that examined a cannabinoid as a potential treatment for opioid withdrawal and found some early promising results. Also, Joshua Lile, associate professor of behavioral science, is involved with several research projects, one of which is using a human laboratory model of cannabis use to evaluate several FDA-approved medications as possible treatments for cannabis addiction, including the anti-epileptic drugs tiagabine (Gabitril) and pregabalin (Lyrica).



# KENTUCKY

## Alumni

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*Photo: UK College of Agriculture, Food and Environment*

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Photo: Steve Patton, Agricultural Communications Services

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