

Years of Silicon Research Yields New License Agreement in FY16

Philip Boudjouk, former Vice President of Research, Creative Activities, and Technology Transfer (RCATT), and Jordan A. Engberg Distinguished Professor of Chemistry has spent many of his years in research with a focus on the chemistry of polysilanes, especially cyclohexasilane, (CHS). The CHS and related new compositions resulting from his team's research have the potential to be used as battery and semiconducting materials, inks for printed electronics applications, and novel photovoltaic devices. CHS can be the basis for a new material for lithium-ion battery anode production. CHS (a polysilane) has a number of advantages over other silane materials. The other silane materials are a flammable gas at room temperature which means they are difficult to store, transport, and use. NDSU scientists have demonstrated that CHS can be used in either gaseous or liquid form to electro-spin amorphous silicon nanowires that may have applications in batteries.



In 2016, a license agreement was signed with Coretec Industries, LLC (later merged with 3Dicon) that enables Coretec to develop and commercialize this valuable technology portfolio. The exclusive license agreement provides access to 12 existing and 2 pending patents representing global intellectual property for these CHS silicon-based technologies. In addition, Coretec has an option to acquire the exclusive licensing rights to an additional 21 pending or issued patents. Coretec's immediate focus will be on energy storage, solar applications, microelectronics, and printable electronics.

Dr. Boudjouk's research team (composed primarily of research scientists, post docs, and former students) included nine NDSU co-inventors that contributed to the technologies licensed to Coretec. A total of 17 co-inventors were involved in the technologies optioned to Coretec. Several of the them were co-inventors on multiple patents for both the licensed and/or optioned technologies.

Coretec is seeking to establish joint development and/or sublicense agreements with strategic partners utilizing this portfolio of CHS based materials for application in the high growth markets identified above, as well as continue research and development efforts with NDSU. Plans are for one of Coretec's anticipated industry partners to begin producing CHS so as to supply industry customers and thereby generate revenue in the near future.

Coretec is a Fargo, North Dakota start-up company. Licensing of this technology portfolio by NDSURF to Coretec further supports the technology-led research and economic development in North Dakota.



Philip Boudjouk in his lab at NDSU

FACT: The NDSU Research Foundation's intellectual property licensing revenue continues to rank high nationally, relative to other universities and/or associated research foundations without medical schools, other land grant universities with and without medical schools, and those peer institutions as defined by the North Dakota University System.

FY16— A Second Record Year of Licensing Income



Executive Summary by Dale Zetocha

The NDSU Research Foundation (NDSURF) set a new record in licensing revenue of nearly \$2.78 million in FY16. The 'Prosper' and 'Faller'

wheat varieties continued to be the leading revenue generators, followed by the first time cashed-in equity of stock sold from a company, and another record year of patent and IP cost reimbursement in FY16.

Ninety-four new licenses or options were executed, including 20 exclusive and 74 non-exclusive. New licenses included a silicon (CHS) portfolio of inventions to a North Dakota start-up company. Several non-exclusive licenses were executed for the 'ND Palomino' pinto bean, 'Rosie' light red kidney bean, 'Talon' dark red kidney bean, and 'ND Bison' soybean varieties in FY16.

NDSURF works in concert with NDSU and the NDSU inventors to protect IP so as to transfer it through licensing to existing and start-up companies. These early stage inventions require considerable R&D before they can be commercialized as a product for the public good. NDSURF and the NDSU Technology Transfer Office have worked with several NDSU inventors to submit Venture Grant proposals under the ND Dept. of Commerce's Research ND program. The Venture Grant program provides grant dollars to further develop these early stage technologies and to determine feasibility of a start-up or spin-off in ND. These could lead to licenses to future start-up companies in the next few years.

Dale Zetocha

The NDSU Research Foundation has worked diligently to increase licensing income from discoveries and inventions that are created from NDSU research. Licensed inventions include agricultural crop and horticultural varieties, paints and coatings, software, thin film chip technology, and more recently, silicon technologies.

The NDSU Research Foundation had another record year of licensing income by bringing NDSU research discoveries to the marketplace. It has seen significant growth in its licensing income, or royalties, license fees, and patent cost reimbursements paid by private companies. This money will be used to further develop, protect, and commercialize new NDSU research discoveries.

Licensing income increased from \$1,884,361 in FY10 to a new record of \$2,779,479 for FY16. This is an increase of over 10% from the previous record of \$2,514,564 set in FY15.

This income demonstrates the research productivity of NDSU faculty. In addition to transferring innovative technologies through licensing for the public good, increasing licensing revenue is important to support future research at NDSU and reward our NDSU inventors for their innovative work.

People in North Dakota benefit from the wide variety of NDSU crop varieties for food and industrial uses. Farmers and agriculture companies profit by using seed from the high quality crop varieties developed at NDSU and licensed by the NDSU Research Foundation. Other NDSU inventions target enhanced human and animal health or improve the quality of products already for sale, such as specialty paints and coatings, that may be used by state citizens.

Through licensing NDSU-developed technologies, NDSURF also has been instrumental in helping start-up companies that support technology-based, economic development in North Dakota. In the past five years, NDSU-developed technologies have been licensed or optioned to a total of nine startup companies. Six of those were North Dakota companies and five of the six are located in the NDSU Research and Technology Park incubator facility.

Technology Licensing Updates



Dakota Technologies, Inc. (DTI) was the first start-up company in North Dakota that licensed a fluorescence-based instrumentation to map subsurface petroleum contamination technology from NDSURF in 1994. DTI has gone through some restructuring which brought in new investment, so as to be able to further grow the company. The new investor offered to purchase NDSURF's equity share in the company. NDSURF agreed and negotiated to sell its equity shares to the new investor in FY16. This is the first cashed-in-equity from the sale of its shares in a company for NDSURF.

FY16 Distribution for Agricultural Research Fees

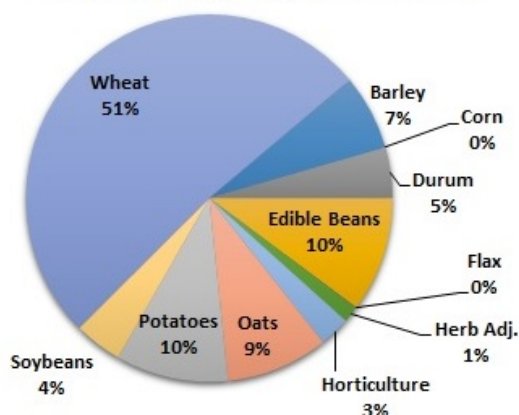
FY16 Agricultural License Revenues were distributed to the following entities:

Distribution Activity	Barley	Durum	Edible Beans	Flax	Herb Adj	Horticulture	Oats	Potatoes	Soybeans	Wheat	Grand Total
BASF										1,723	1,723
Breeder/Inventor	28,016	22,186	52,847	156	8,179	6,470	50,542	26,387		298,214	492,997
Carrington REC			40								40
Langdon REC								564			564
ND Soybean Council									3,209		3,209
NDCISA										396	396
NDSU AES	3,425	2,162	5,684	14			3,639		597	25,623	41,144
NDSU Entomology										108	108
NDSU FSS	2,802	2,162	2,372	14			3,577		1,504	25,606	38,037
NDSU Plant Path	8,172	2,162	10,951					58,658	3,040	59,661	142,644
NDSU Plant Sci	55,432	29,549	58,019	204	12,268	26,224	59,158	66,146	48,527	103,896	459,423
NDSU Plant Sci Endow										208,384	208,384
NDSU RF Endow	9,341	4,720	18,401	40	2,045	2,801	15,750	12,435	6,748	80,644	152,925
NDSU Soil Sci									1,505		1,505
UMN Foundation										3,790	3,790
Grand Total	107,188	62,941	148,314	428	22,492	35,495	132,666	164,190	65,130	808,045	1,564,889

Royalties & License Fees

Barley	143,258	Horticulture	58,562
Corn	0	Oats	193,982
Durum	96,421	Potatoes	213,966
Edible Beans	218,866	Soybeans	91,866
Flax	579	Wheat	1,106,270
Herb Adj.	30,291	Total	2,154,081

NDSU Research Foundation FY16 Ag Royalty/Fee Income



NDSU Research Foundation Expands Offerings



The NDSU Technology Transfer Office and NDSURF had their second most prolific year of disclosures with a total of 58 disclosures including: 38 technology disclosures; 17 plant disclosures; 2 horticultural disclosures; and one in a new category, creative activities. NDSURF also expanded its footprint in two other ways. First of all, social media accounts have been reactivated using Twitter and Facebook. These provide avenues to reach potential licensees for our technologies. Although these efforts are just starting up again, our following is growing. Our target audience is the younger social media generation who are either involved with start-ups or who work for decision makers at larger established companies. Secondly, six new provisional patent applications were prepared internally. This reduced costs and sometimes allowed filing prior to disclosure of technologies that otherwise would be lost. The attorney preparation cost is zero, and the quality of the application is better, because we take the time to make the provisional application "conversion ready." The estimated cost savings for each internally filed patent application is between \$2,000 - \$7,000.

NDSU Agricultural Varieties

**Contributing to Revenue
in FY16**

Barley

Conlon
Pinnacle

Durum

Alkabo
Carpio
Divide
Grenora
Tioga

Edible Beans

Avalanche Navy Bean
Eclipse Black Bean
Lariat Pinto Bean
Maverick Pinto Bean
ND307 Pinto Bean
Rio Rojo Small Red Bean
Stampede Pinto Bean

Flax

Carter

Oats

Beach
Comet
Drover
Hi-Fi
Jury
Newburg
Nugene
Rockford
Souris
Taipan

Potatoes

AC Peregrine Red
Dakota Crisp
Dakota Diamond
Dakota Jewel
Dakota Pearl
Dakota Rose
Dakota Ruby
Dakota Russet
Dakota Trailblazer
NorDonna
NorValley

Soybeans

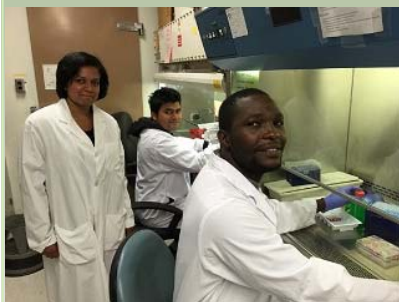
Blue Horizon
Cavalier
ProSoy
Sheyenne
Trail
ND1005T
ND1100S
ND1406HP

Wheat

Barlow
Elgin ND
Faller
Glenn
Mott
ND901CL PLUS
Steele
Prosper
Velva

Animal Health Technologies Proliferate

The NDSU Research Foundation is seeing increased activity in animal health. Recent technologies include swine vaccines and predictive pregnancy tests.



Dr. Sheela Ranamoorthy of Veterinary and Microbiological Sciences is developing vaccines to treat three pig viral diseases. One of these diseases led to the destruction of 25 percent of the pig population in the U.S. in 2013. The vaccines have the added feature of being DIVA vaccines, which means the ability to differentiate infected versus vaccinated animals when small amounts of viral proteins are detected in a pig.



Dr. Kim Vonnahme of Animal Sciences and her graduate student Tori Kennedy have invented a method to determine whether an animal is likely to have a successful pregnancy before the animal is inseminated and to confirm pregnancy after insemination. The method also can indicate litter size. This is important because the costs rise each day a food or dairy animal meant for breeding is not pregnant. Applications include farm animals such as cattle, dairy cows, sheep, and pigs, but is also applicable to wildlife, such as threatened, endangered, and exotic animals. Consider the excitement every time a panda bear or polar bear is born at a zoo.

Ms. Kennedy is currently doing research to gauge the health of wildlife populations by applying the method to "samples" left by wildlife. Ms. Kennedy is presently interning with the Smithsonian Institute where she is exploring the use of this method with exotic animal species.



**NDSU Research Foundation
Statement of Revenues and Expenses**

July 1, 2015 - June 30, 2016

Income	
Research Fees and Royalties	\$2,225,447
License Fees	103,400
Patent Cost and Other Reimbursements	197,798
Litigation Settlements	1,867
Interest	13,500
Dividends	119,782
Gain on Sale of Equity in Private Co.	252,834
Investment Return	52,797
Total Income	\$2,967,425
Expenses	
Total Legal and Related	536,311
Patent	\$506,356
Licensing	12,539
Plant Variety Protection and Related	13,048
Research Fee Collection & Other	2,493
Trademark	1,875
Total Salaries and Operating	288,925
Total Research Fees and Royalties Disbursed	1,755,889
NDSU Dept/College/NDAES	1,206,503
Breeder/Inventor	540,269
Non-NDSU Royalty Disbursed	9,117
Total Expenses	\$2,581,125
Increase in Net Assets	386,300
Net Assets at Beginning of Year	\$6,921,064
Net Assets at End of Year	\$7,307,364

**NDSU Research Foundation
Statement of Assets and Net Assets**

June 30, 2016

Assets (Foundation)	Market Value
Current Assets (Foundation)	
Operating Checking and Savings	\$18,672
Fund 81294	67,448
Other Savings	450,679
Prepaid Expenses	12,836
Receivables	75,000
Total Current Assets	\$624,635
Property & Equipment	
Office Equipment	19,340
Less: Accumulated Depreciation	(15,689)
Net Property & Equipment	3,651
Other Assets	
Plant Sciences Endowment Assets:	
Durum Wheat Endowment	
Money Market	0
Mutual Funds	1,904,733
Spring Wheat Endowment	
Money Market	0
Mutual Funds	2,995,658
Total Plant Sciences Endowments	\$4,900,391
Sociology Endowment	\$0
Anthropology Endowment	\$0
University Studies Endowment	\$0
Math Endowment	\$25,514
Science & Math Endowment	\$1,917
ADHM Endowment	\$2,808
Assets (NDSU/RF Endowment)	
Cash Accounts (Endowment)	
Money Market State Bank and Trust	16,918
Money Market RBC Wealth Management	420,303
Total Cash Accounts (Endowment)	\$437,221
Investment at RBC Wealth Management	-0-
Investment at State Bank and Trust	876,883
Investment at Vanguard - S&P 500	482,982
Total NDSU/RF Endowment Investments	\$1,777,096
Total Other Assets	\$6,707,526
Total Assets	\$7,335,812
Restricted Assets (Foundation)	
Restricted Assets - Anthropology	\$0
Restricted Assets - Math	25,514
Restricted Assets - Plant Sciences	4,900,391
Restricted Assets - Sociology	0
Restricted Assets - University Studies	0
Restricted Assets - Science & Math Endowment	1,917
Restricted Assets - ADHM	2,808
Restricted Assets - NDSU/RF Endowment	1,777,096
Unrestricted Assets	599,838
Total Restricted and Unrestricted Assets	\$7,307,364

**Seven Plant Variety Protection Certificates (PVP's) Issued in
FY16**

- 'ND1406HP' soybean issued September 29, 2015
- 'Joppa' durum issued September 29, 2015
- 'Talon' dark red kidney bean issued September 29, 2015
- 'Rosie' light red kidney bean issued September 29, 2015
- 'ND Henson' soybean issued December 9, 2015
- 'Gold ND' flax issued December 9, 2015
- 'Dakota Ruby' potato issued May 12, 2016



**Horticultural Varieties
Contributing to Income
in FY16**

- Copper Delight™
Juniper
- Prairie Splendor™
Juniper
- Dakota Goldcharm®
Spirea
- Dakota Goldrush®
Potentilla
- Dakota Sunspot®
Potentilla
- Prairie Dome®
Ash
- Prairie Gem®
Flowering Pear
- Prairie Spire®
Green Ash
- Dakota Pinnacle®
Asian White Birch
- Blueberry Delight®
Juniper
- Copper Curlys®
Pekin Lilac
- Northern Acclaim® Thorn-
less Honey-locust
- Prairie Dream®
Paper Birch
- Prairie Horizon®
Manchurian Alder
- Prairie Torch®
Hybrid Buckeye
- Prairie Statesman® Swiss
Stone Pine
- Prairie Expedition®
American Elm
- Prairie Stature®
Hybrid Oak
- Prairie Reflection®
Laurel Willow
- Spring Welcome®
Magnolia
- Northern Tribute®
River Birch
- Royal Splendor®
Norway Spruce
- Northern Flare®
Sugar Maple
- Prairie Pioneer®
Dwarf Chinkapin Oak
- Northern Herald®
Eastern Redbud
- Northern Spotlight™ Kore-
an Maple

New Agricultural Varieties Licensed in FY16

'ND Palomino' pinto bean was licensed to nine companies in FY16. This pinto bean possesses a naturally occurring gene which delays seed coat darkening during both harvest and storage. This slow-darkening gene (sd) is recessive, and its original sources don't have good agronomic performance (low seed yield, prostrated plant type, etc.). ND Palomino is one of the first cultivars that combine good agronomic performance with the slow darkening gene. 'ND Palomino' will be protected under the Plant Variety Protection Act (PVP). Dr. Juan Osorno is the Edible Bean Breeder at NDSU.

'ND Bison' soybean was also licensed to twenty-one companies in FY16. "ND Bison has high yield, is a 0.7 maturity, has resistance to Race 4 of Phytophthora root rot and is moderately resistant to Soybean Cyst Nematode HGO. It is a non-GMO type with purple flowers and tawny pubescence. 'ND Bison' will be protected under the Plant Variety Protection Act (PVP). Dr. Ted Helms is the Soybean Breeder at NDSU.

'Rosie' light red kidney bean was licensed to five companies and **'Talon' dark red kidney bean** was licensed to nine companies in the spring of 2016. Both have been tested across environments in Minnesota and have shown a superior seed yield when compared with other cultivars commonly grown in the region. 'Rosie' holds Plant Variety Certificate (PVP) No. 201500066 and 'Talon' holds PVP Certificate No. 201500067. Dr. Juan Osorno is the Edible Bean Breeder at NDSU.



'ND Bison' soybean

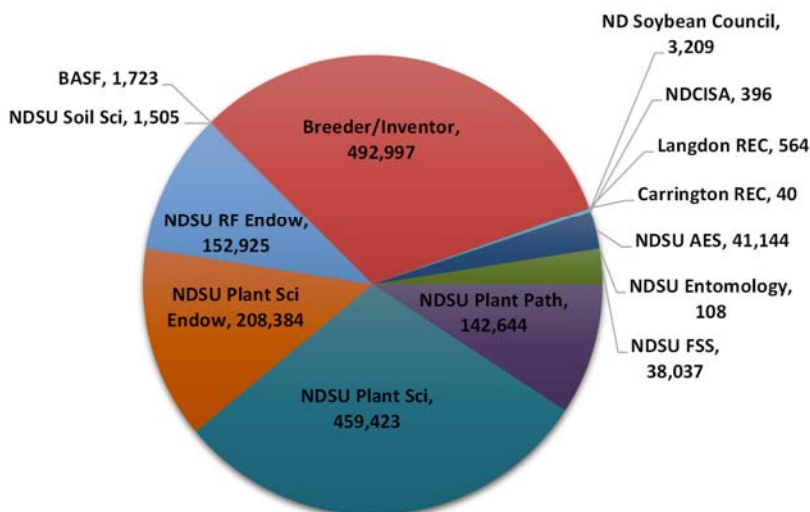


'Rosie' light red kidney



'Talon' dark red kidney

NDSU Research Foundation FY16 Distribution Activity



NDSURF Mission:

The mission of the NDSU Research Foundation is to provide support for NDSU by protecting, adding value to and commercializing intellectual property that is developed through research activities at NDSU.

Origin of NDSURF:

The NDSU Research Foundation was established May 30, 1989, and incorporated in North Dakota as a scientific and educational not-for-profit organization under Section 501 (c) (3) of the Internal Revenue Code to interact with business and industry and to expand NDSU's ability to commercialize its research discoveries.

Technology Licensing Updates, Continued



Today's electronic devices are flat, boxy, and rigid. They involve thick, rigid integrated circuits (ICs) that are easily positioned onto circuit boards and connected. However, the real world is flexible and curvy, and the next-generation of electronic devices are envisioned to be flexible and curvy as well. This requires ICs that are thinned to the point they become flexible. This makes handling and connecting them very difficult and incompatible with existing solutions.

Uniqarta is addressing this problem with technology licensed from the NDSU Research Foundation. This technology replaces the current "pick-and-place" method of positioning ICs with a novel, laser-based approach developed at NDSU. The company has received two Small Business Innovation Research grants from the National Science Foundation to optimize and expand on this technology and has also been selected for multiple development projects by NextFlex (www.nextflex.us)—a government-funded institute focused on flexible hybrid electronics.

The company has established several promising commercial partnerships focused on flexible electronics manufacturing and operates an R&D center in Fargo . [For more information go to: http://www.uniqarta.com](http://www.uniqarta.com)



Comparison of conventional "thick" IC with a flexible thin one. The thick IC does not conform to the circuit board contour, nor is it connected at the edges.



Over the past year, c2renew has continued to work with our partner companies to provide new material solutions to improve on current material, introduce new materials, or solve a technical problem. One big milestone was achieved with a consumer partner company. A product that c2renew manufactures material for was launched into a larger big box retailer. C2renew is excited to see the hard work over the years on the shelves of a store where they can point their friends, family, and potential customers.

[For more information go to: http://www.c2renew.com](http://www.c2renew.com)



c2sensor continued a busy year of development and in-field trials on the SEED sensor technology. The company made some important changes to the hardware architecture that improved functionality and use. c2sensor is looking into the future to see how they can expand the uses of the sensor platform, and how they can ensure that growers get the most relevant and actionable data possible. To achieve that end, software was developed that allows them to collect, analyze, and expose the data to any ag related software

platform. This enables growers to use the data immediately in their operations.

[For more information go to: http://www.c2renew.com/c2sensor](http://www.c2renew.com/c2sensor)



Fluorescence Innovations (FI) is located in Minneapolis, MN, and operates in space leased from the University of Minnesota (UMN). FI develops advanced fluorescence microplate readers for drug discovery and basic research applications. In the past year, FI has advanced into reading 1536-well plates, which is the preferred format for high-throughput screening in large pharmaceutical companies. These are very demanding experiments, because the sample volumes are very small, approximately one-tenth the size of a water drop and must be conducted very quickly, typically ten samples per second. While conventional microplate readers can only meet these requirements with a simple intensity measurement, FI is uniquely able to record fluorescence decay curves and now, full fluorescence spectra. A patent has been applied for on the spectral recording innovation. The work is supported by two large contracts with major pharmaceutical companies and a Phase 2 STTR grant from NIH. [For more information go to: http://www.fluorescenceinnovations.com](http://www.fluorescenceinnovations.com)

Agricultural Breeding Programs at NDSU



Dr. Juan Osorno,
NDSU's Edible Bean Breeder

NDSU, through the ND Agricultural Experiment Station (NDAES), is the home of 13 crop/plant breeding programs. The NDAES was established (according to the Hatch Act) in North Dakota in 1890 “to promote efficient production, marketing distribution, and utilization of products of farms as essential to health and welfare of our peoples and ...to assure agriculture’s position in research equal to that of industry”. The NDAES consists of seven research extension centers located throughout the state as well as the main station on the NDSU campus.

The 13 crop/plant breeding programs and the respective breeders include: Hard red spring wheat (Andrew Green), hard red winter wheat (G. Francoise Marais), durum wheat (Elias Elias), barley (Richard Horsley), potato (Susie Thompson), soybean (Ted Helms), dry bean (Juan Osorno), oats (Michael McMullen), corn (Marcelo Carena), flax (open—previously James Hammond), canola (Mukhlesur Rahman), pulse crops (Kevin McPhee), and woody plants (Todd West).

While some of the breeding programs are relatively new, several of them have played a key role in providing high yield and quality crop varieties that have enabled North Dakota to be consistently one of the top producer(s) of several key crops in the United States. In addition, NDSU developed varieties have been the top variety or within the top few varieties planted in North Dakota. This speaks well for the quality of work of all the breeding and research programs at NDSU and the NDAES.

NDSURF protects and licenses these NDSU developed varieties and the research fees/royalties from these varieties have been and continue to be the major source of licensing revenue for NDSURF. A portion of this revenue is distributed to the contributing NDSU units and breeders. NDSURF has distributed over \$17 million (from FY94—FY16) to the NDSU units in order to supplement on-going research by NDSU breeders. NDSURF congratulates the current and past breeders for a job well done in developing high quality and yielding varieties that provide food and industrial benefits to North Dakota, the United States, and many countries around the world.

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