Addendum to 2013 TCAP report documenting Economic impact of the project

Economic impact of public wheat and barley varieties: $12-billion/year

We completed a survey that includes information for 33 states for wheat and 10 states for barley and that cover 97% of the US wheat acreage (Appendix I) and 84% of the barley acreage (Appendix II).

Production of small grains in the US in 2012 was $17.8 billion for wheat and $1.4 billion for barley (based on USDA-NASS 2012 statistics). Based on our survey, public varieties account for 68% of the wheat ($ 11.5 billion) and 34% of the barley ($413 million) total production. These numbers indicate that public breeding programs are still making a significant contribution to the production of these two crops in the US.

The barley and wheat public breeding programs are an example of collaboration between the private and public sector. Growers provide funding for the core breeding activities and USDA provides the research support through CAP, other grants, and USDA-ARS infrastructure required to keep these programs competitive.

The $12-billion production value of public wheat and barley varieties is amplified multiple times through the milling, baking, malting, and brewing industries that contribute additional jobs and value to the economy. Private companies routinely use public varieties in their crossing blocks, transferring part of this value to the private sector and further multiplying the economic benefits of the public breeding activities. We include at the end of this report a letter from the National Association of Wheat Growers and the North America Miller's Association documenting the value of the products of TCAP for the US growers.

An additional impact of the public varieties that is difficult to estimate economically is their emphasis on genetic disease resistance. The use of molecular markers has enabled breeders to pyramid multiple resistance genes improving resistance durability. The use of genetically resistant varieties developed by the public sector reduces the use of pesticides minimizing potential negative effects on people and the environment and saving the growers application costs.

Impact of CAP projects on production values of wheat and barley varieties

Based on our survey, we estimated that wheat and barley varieties developed with total or partial support of the CAP projects (WheatCAP, BarleyCAP and TCAP) represent roughly 20% of the wheat and 4% of the barley harvested acreage, with a production value of $3.5 billion for wheat and $62 million for barley.

To estimate how much of this value was specifically added by the CAP projects (BarleyCAP, wheatCAP and TCAP), we made the following conservative assumptions:

1) If a variety is grown commercially there must be a perceived increased value compared to other available varieties. Thus, we assumed that the currently grown varieties developed by these projects have at least a 5% advantage in production values to justify the grower's decision to buy seed for a new variety. Therefore, we calculated first the 5% of the production value for wheat ($170.8 million) and barley ($3.1 million).

2) Varieties differ in the proportion of funds received from CAP projects and local breeding programs for their development. Some were completely developed using funds from CAP projects (e.g. MAS backcrossing programs such as Patwin 515 in CA) and others received funds from CAP projects for part of the variety development costs (e.g. selection of parental lines used in the initial crosses or selection of favorable alleles with markers). To be conservative we estimated that, on average, 10% of the variety development was contributed by the CAP projects.

We then calculated this 10% over the 5% additional production value of the CAP barley and wheat varieties (0.5% of their total value). The resulting estimate was $17.2 million per year of added value to current barley and wheat varieties by CAP projects. This is more than three times the value of current TCAP investment per year including education and overhead costs. The return value of breeding activities only materializes 5-10 years later when the resulting varieties are released, so return from the current investments are expected to extend into the future and expand as high-throughput marker technologies permeate more and more breeding activities.

Economic impact of the information and technological tools generated by CAP projects

In addition to the value captured by the public sector, part of that value of this investment is also transferred to the private sector. The maps, marker information, and marker technological developments (ISelect 9K and 92K chips, exome capture platforms, maps, etc.) are actively used by the wheat and barley private sector in the US. Many private companies use markers developed by the public sector, and even use the USDA marker labs. For example marker labs at Pioneer, Syngenta, Dow, KWS, Limagrain, and Monsanto have requested the KASP assays developed by the USDA-ARS genotyping laboratory located at Raleigh, NC. Companies actively use the MASWheat site for MAS protocols and have acknowledged the value of the site. In the east, many "private" varieties actually originate from public institutions. Purdue and Illinois release most varieties for licensing to private companies. TCAP and previous Wheat and Barley CAP project results serve the entire US wheat and barley breeding industries. In California, the public wheat breeding program has provided MAS backcrossing services and introgressed stripe rust resistance genes *Yr5, Yr15, Yr17* and *Yr36* and the high grain protein content gene *Gpc-B1* in several private varieties that are now extensively grown in California (e.g. Blanca Grande 515, Summit 515, Expresso, Westmore, etc.).

We include a letter from the National Association of Wheat Growers documenting the positive perception of US wheat growers on the economic impact of the TCAP project. Testimonials from wheat growers recognizing the value of plant breeding are also documented in the TCAP film available at https://vimeo.com/72364589.

The genetic information generated from these projects provided a better understanding of the genetics of a target trait. For example, the mapping of the solid stem trait revealed a single major gene controlling solidness. The selection strategy for the leading solid stem variety in Montana ('Vida', 500,000 acres), was based on the genetic information obtained by the USDA-funded IFAFS program. Genetics studies have improved our understanding of the inheritance of multiple agronomic traits, which helps to design efficient breeding strategies (in addition to their direct value in MAS).

The information generated from the BarleyCAP and TCAP grants was transformative: it unlocked marker densities and breeding systems that have made genomic selection feasible. Consequently, genomic selection became a research and an educational reality. It was passed on to students and postdocs who now are using that framework as breeders in industry. These grants have also leveraged learning and education beyond the strict set of students that they funded by providing seminars, workshops and an active cohort of students interested in plant breeding.

Economic impact of the training provided by the CAP grants

We performed a survey to identify the current positions of people trained during the BarleyCAP, wheatCAP and TCAP projects (Table 1). We identified 57 individuals that currently hold positions in companies located in the US, including of the breeding and seed companies. Forty are currently working in academic institutions in the US and 18 are working in other countries (public or private). This data confirms that the CAP projects have contributed significantly to the training of the personnel currently hired by the private sector in the seed industry.

The last decade has witnessed the dismantling of many breeding programs in the public sector and their transfer to the private sector. This has resulted in limited training opportunities for students interested in plant breeding, and has resulted in a shortage of plant breeders nation-wide. The small grain breeding programs represent one of the last reservoirs of active breeding programs in the public sector that can be used to train students.

This is well documented by the huge demand of industry for the students trained by the IFAFS/CAP/TCAP projects that have been rapidly incorporated into different breeding industries in the US and abroad.

Table 1. Current positions of people trained during BarleyCAP, wheatCAP and TCAP projects.

State	Trainee	Current position
CA	Malena Faricelly	Pioneer USA
CA	Iago Hale	Professor at the University of New Hampshire
CA	Juan Carlos Brevis	Onion Breeder private sector
CA	Cristobal Uauy	Project Leader at the John Innes Centre, UK
CA	Kati Wu	Amyris Biotechnologies Associate scientist
CA	Marco Maccaferri	University of Bologna
CA	Juan Sanchez	Monsanto
CA	Eligio Bossolini	Bayer Europe
CO	Kelsey Salvo	U.S. Peace Corps, Senegal
CO	Jessi Davis	KSU graduate program
CO	Elizabeth Bloetvogel	Eurofins STA Labs, Longmont, CO
CO	Beth Econopouly	Gates Foundation, Seattle
CO	Erena Edae	USDA-ARS, Manhattan, KS
CO	Anna Pranger	Syngenta, Longmont, CO
CO	Annie Heiliger	Cargill, Fort Collins, CO
CO	Shusong Zheng	Academy of Sciences, Beijing
CO	Wahid El-Feki	University of Alexandria, Egypt

CO	Melaku Mekonnen	Syngenta, Junction City, KS
CO	Joshua Butler	Busch Agricultural Resources
CO	Sally Clayshulte	Bayer Crop Science
CO	Ben Beyer	Advanta US
CO	Jennifer Andeway	Monsanto
CO	Victoria Valdez	Colorado State Univ.
CO	Karla Rippe	Pioneer
CO	Nelson Hevner	Monsanto
IA	Shenqiang Zhong	Monsanto
IA	Elliot Heffner	Pioneer Hibred Intl.
IA	Yi Jia	Dow Agrosciences
IA	Aaron Lorenz	Assistant Professor, University of Nebraska
IA	Jesse Poland	Research Plant Geneticist, USDA-ARS, Manhattan, KS
IA	Victoria Blake	Geneticist, USDA-ARS, Albany, CA
IA	Deniz Akdemir	Postdoctoral Fellow, Cornell University, Ithaca, NY
IA	Martha Hamblin	Senior Research Associate, Cornell University, Ithaca, NY
ID	Reuben Mclean	Production manager at Pendleton Flour Mill, Blackfoot, ID
ID	Maqsood Rehman	DowAgscience, leader Soybean breeding for North America
ID	Mackenzie Ellison	DowAgscience wheat breeding Pullman, WA. Research tech
ID	Justin Wheeler	Support scientist at University of Idaho
ID	Junli Zhang	Project leader, University of California, Davis
ID	Ping Li	Assistant Professor, Huazhong Agric. Univ. Wuhan, China
KS	Xiaofei Wang	Bioinformatician University of Kansas
KS	Shubing Liu	Research Scientist in KSU
KS	Amy Bernardo	Research Scientist in KSU
KS	Irazema Fuentes-Bueno	USDA-ARS, Manhattan, KS as technician
KY	Lloyd May	Monsanto
KY	Beiyan Zeng	Monsanto
KY	Virginia Verges	Don Mario Seeds
KY	Andres Agostinelli	Limagrain
KY	Ana Balut	Monsanto Argentina
KY	Carrie Knott	UK faculty
KY	Herry Utomo	LSU
MN	Xiuling Zhang	Corn Breeder, Pioneer Hi-Bred, Mankato MN
MN	Alex Rigor	Rice Breeder, Pioneer Hi-Bred, Philippines
MN	Toi Tsilo	Wheat Geneticist, Agricultural Research Council, South Africa
MN	Ed Quirin	Marker Analytics, Pioneer Hi-Bred, Johnston IA
MN	Godwin Macharia	Kenya Agricultural Research Institute, Kenya
MN	Brian Seda	Soybean Breeder, Pioneer Hi-Bred, York NE
MN	Trevor Keith	Research Associate, Pioneer Hi-Bred
MN	Jon Massman	Pioneer
MN	Carol Powers	Dow
MN	Vikas Vikram	Monsanto

MN	Warren Kruger	Monsanto
MN	Hongyun Wang	Pioneer Hi-Bred
MN	Michael Van de Weghe	Pioneer Hi-Bred Intern
MT	Hussein Abdul-Haleem	University of Georgia
MT	Jeremy Jewell	Washington State University
MT	Deven See	Washington State University
MT	Steve Larson	USDA-Logan, Utah
MT	Don Lee	Univ. Nebraska, Lincoln
MT	Jeong Shin	Seoul University
MT	Jason Cook	Monsanto
MT	Yukiko Naruoka	Washington State University
MT	Gail Sharp	Monsanto
MT	John Erpelding	USDA Scientist
MT	Megan Hartzell	Forage Genetics
MT	Peng Wah Chee	University of Georgia
MT	Xueyan Shan	Misissippi State University
MT	Eric Storlie	Colorado State University
NY	Chiranth C. Rajashekar	Sathguru, India
NY	Keith Williams	Agreliant
NY	Emily Combs	DuPont Pioneer
ND	Ana Correa-Heileman	Monsanto
ND	Magan Lewis	Dow AgroSciences
ND	Fabio Pedraza	Seeds 2000
NE	Nicholas Crowley	Corn Breeder, Pioneer
NE	Neway Mengistu	Corn Breeder, Pioneer
NE	Kayse Onweller	Assistant Wheat Breeder, Bayer Crop Science
NE	Ali Bakhsh	Professor, College of Agriculture Dera Ghazi Khan
NE	Anyamanee Auvachanon	Professor, Kasetsart University at KPS, Thailand
NE	Ibrahim Salah El-Baysoni	Postdoctoral Scientist, University of Nebraska
NC	Jared Benson	Molecular Breeding Scientist, Pioneer Hi-Bred
NC	Leandro Perugini	Research Scientist, Pioneer Hi-Bred
NC	Tristan Coram	Agronomic & Phenotyping Group Leader at Dow AgroSciences
NC	Raja Kota	Senior Scientist, Syngenta
NC	Eric Olson	Assistant Professor, Wheat Breeding Michigan State University
NC	Marla Hall	Wheat Breeder, Limagrain Cereal Seeds
OK	Chor_Tee Tan	Texas A&M University - Texas AgriLife
OK	Tilin Fang	Oklahoma State University
OK	Tianrong Huang	Inst. Grain Crops, Xinjiang Acad. Agric. Sci., P.R. China
OK	Xinkai Zhu	Yangzhou University, P.R. China
OR	Juan Rey	Dow Agrosciences
OR	Scott Fisk	Oregon State University
OR	Alfonso Cuesta-Marcos	Oregon State University

OR	Natalie Graham	Cos County, Oregon
OR	Yada Chutimanitsakun	Kasetsart University
OR	Kelley Richardson	USDA/ARS
VA	Greg Berger	Hybrid Rice Breeder, U. of Arkansas, Rice RE Center, Stuttgart, AR
VA	Mark Christopher	Assistant Wheat Breeder, KWS-U.S., Wooster, OH
VA	Pat O'Boyle	Sugar Beet Breeder, Betaseed, Inc., Shakopee, MN.
VA	Sam Markell	Assistant Professor, North Dakota State University, Fargo, ND
VA	Jianli Chen	Assistant Professor, University of Idaho, Aberdeen, ID
VA	Jafar Mammadov	DOW Agro Sciences, Indianapolis, IN
VA	Robert Paris	Research Geneticist, American Chestnut Foundation, VA
VA	Sixin Liu	Molecular Biologist, USDA-ARS, Kearneysville, WV
VA	Young-Soo Chung	Professor, Korea University, Seoul, South Korea
WA	Carter, Arron	Washington State University

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Lead PI's, USDA-NIFA TCAP Grant

Dear Drs. Dubcovsky and Muehlbauer:

The National Association of Wheat Growers (NAWG), its member states and state wheat organizations across the country have long supported your USDA-National Institute of Food and Agriculture (NIFA) TriticeaeCAP (TCAP) grant work to improve barley and wheat germplasm for changing environments. We appreciate your report on the third year of this work and, based on your progress and continued work, we are pleased to reiterate our support for your vital work

We are impressed by the progress achieved in such a short period of time. In particular we would like to recognize the TCAP project for the release of more than 90 new varieties and germplasm, which are essential to maintain the competitiveness of the wheat crop and wheat growers. Improved varieties from TCAP and previous USDA-funded CAP projects are having a positive economic impact on our industry. It has long been recognized that the release of a new cultivar represents a significant return on investment. For example, an economic analysis of Kansas wheat breeding by Barkley (1997) estimated a return of 39% on investment of public dollars (KAES Progress Report 793). Thus, it is clear that the economic impact of the new variety releases is significant.

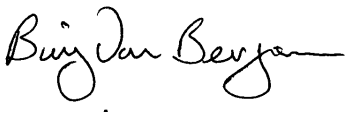
Importantly, your work within the TCAP project has led to the identification of new resistance genes against leaf rust, stem rust and stripe rust and their deployment in new varieties. This is an

accomplishment that has enormous agronomic, environmental and economic benefits, reducing the need for expensive fungicides and increasing the productivity and profitability of our wheat growers.

We also recognize the long-term impact of the TCAP project's emphasis on the training of new wheat breeders. Wheat growers are focused on improving their production practices in the short term, and they understand that wheat research is a long-term proposition necessitating infrastructure in the form of human and monetary resources. Your ability to work closely with the next generation of breeders may be your most significant contribution to the overall economic health and longevity of the wheat industry.

In summary, we continue to be grateful for the TCAP project's focus on long-term environmental concerns such as climate change and nitrogen use efficiency as well as the significant economic impact that this project is already having on the wheat industry. We look forward to continued work together with you and your colleagues.

Sincerely,



Bing Von Bergen
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Dr. Jorge Dubcovsky
Professor
University of California, Davis

Dr. Gary Muehlbauer
Professor
University of Minnesota

Re: USDA-NIFA TCAP Grant

Dear Drs. Dubcovsky and Muehlbauer:

The North American Millers' Association (NAMA) and its member companies have, since its inception, supported your USDA-NIFA Triticeae Coordinated Agricultural Project (TCAP) grant proposal entitled "Improving Barley and Wheat Germplasm for Changing Environments" and are pleased to reiterate our support now. Thank you for sending us your report for the third year of the TCAP project.

We are impressed by the progress achieved in such a short period of time. In particular we would like to recognize the TCAP project for the release of more than 90 new varieties and germplasms. New wheat varieties that deliver excellent milling quality are essential to the competitiveness of the US milling industry and downstream stakeholders. Improved varieties from TCAP and previous USDA-funded CAP projects are having a positive economic impact on our industry. While it is difficult to place an exact dollar value on the impact of a new variety, most agree that a ratio of $30 to $50 returned for each dollar invested is reasonable. Thus, it is clear that the economic impact of these new releases is significant.

Secondly, we note the identification of new resistance genes against the three rusts and their deployment in new varieties. This is an important accomplishment with major economic consequences. Disease resistance is a crucial trait for the wheat industry because it improves the competitiveness of wheat production, and allows farmers to avoid applying fungicides which meets the sustainability goals of our customers and the preferences of consumers.

Thirdly, we thank the two of you and your fellow scientists for the huge emphasis the TCAP project places on the training of new wheat breeders. This effort will confer longevity to the entire wheat industry.

In summary, it is good to see that the TCAP project can addresses long-term environmental concerns such as climate change and nitrogen use efficiency while having an immediate, significant economic impact on the wheat milling industry.

Sincerely,

Jim Bair

James A. Bair
Vice President

Appendix I. Acreage and production from wheat public varieties (and from varieties generated by MAS)

State	Acres planted	Acres harvested	Yield tons/ac	Avg. price per ton	Production value $	Acres public varieties	Value pub var	Ac. pub. var. with markers	Value pub. var. with markers	Source
AZ	115,000	112,000	2.6	347	99,456,000	NA	NA	11,000	9,768,000	Oli Cantu APB (Westmore 11,000 ac collaboration APB-UCD)
AR	550,000	450,000	1.5	255	172,013,000	135,000	51,603,900	67,500	25,801,950	Estimate of Univsersity Wheat Breeder Esten Mason
CA	690,000	414,000	2.5	305	337,049,000	174,700	79,392,081	118,200	89,526,274	2013 California Wheat Commission Variety Survey
CO	2,363,000	2,182,000	0.9	295	602,099,000	1,914,030	528,155,614	1,339,821	369,708,930	Colorado Agricultural Statistics 2012 Variety Survey
DE	85,000	80,000	2.0	290	46,768,000	72,000	42,091,200	12,000	7,015,200	VA breeder Carl Griffey
GA	290,000	230,000	1.3	268	82,271,000	161,000	57,589,700	34,500	12,340,650	Estimate of Univsersity Wheat Breeder Jerry Johnson
ID	1,313,000	1,253,000	2.1	303	808,450,000	614,254	376,507,553	15,000	9,678,172	Idaho Wheat Commision, Wheat breeder (J. Chen) estimation
IL	660,000	645,000	1.7	257	284,445,000	NA	NA	NA	NA	NA
IN	350,000	300,000	1.8	270	147,735,000	NA	NA	NA	NA	NA
KS	9,500,000	9,100,000	1.1	277	2,885,610,000	4,495,400	1,368,471,686	2,402,400	761,801,040	Kansas Agricultural Statistics Wheat Varieties Vol 13, No. 1
KY	580,000	470,000	1.7	264	209,808,000	200,000	72,316,800	100,000	44,640,000	KSIA, farmer surveys
LA	285,000	275,000	1.3	253	92,978,000	192,500	65,084,600	41,250	13,946,700	Estimate of Univsersity Wheat Breeder Stephen Harrison
MD	310,000	210,000	1.9	292	113,526,000	189,000	102,173,400	31,500	17,028,900	VA breeder Carl Griffey
MI	570,000	540,000	2.1	295	330,372,000	270,000	165,186,000	81,000	49,555,800	Estimate of Univsersity Wheat Breeder Eric Olson
MN	1,390,000	1,347,000	1.6	317	662,380,000	821,670	404,051,800	808,200	397,428,000	USDA-NASS, MNAWG,wheat breeders UMN, NDSU, SDSU
MS	370,000	345,000	1.6	251	134,705,000	NA	NA	NA	NA	NA
MO	790,000	690,000	1.6	253	271,377,000	241,500	94,981,950	-	-	Personal estimate MO wheat breeder Anne Mckendry
MT	5,770,000	5,585,000	1.0	313	1,661,318,000	4,077,050	1,212,762,140	203,853	60,638,107	Montana Agricultural Statistics Service and L. Talber (wheat breeder)
NE	1,380,000	1,300,000	1.1	295	429,065,000	1,073,800	354,407,690	625,300	206,380,265	Nebraska Agricultural Statistics Service
NY	100,000	85,000	1.7	306	44,714,000	25,500	13,414,200	12,750	6,707,100	USDA-NASS, Mark Sorrells (wheat breeder) personal estimate
NC	830,000	750,000	1.6	248	288,563,000	375,000	144,281,500	112,500	43,284,450	Estimate Paul Murphy (wheat breeder)
NDw*	750,000	700,000	1.5	231	242,550,000	376,800	130,561,200	49,400	17,117,100	USDA-NASS, NDSU Winter Wheat Breeders (M. Gideon)
NDs*	5,750,000	5,700,000	1.2	317	2,180,250,000	4,370,000	1,656,990,000	35,055	13,625,601	USDA-NASS, NDSU Spring Wheat Breeders (M. Mergoum)
NDd*	1,340,000	1,330,000	0.9	292	338,624,523	1,326,000	337,606,104	-	-	Durum wheat Breeder Elias Elias
OH	500,000	450,000	1.9	308	260,820,000	180,000	104,328,000	22,500	13,041,000	Estimate by OSU wheat breeder (Clay Sneller)
OK	5,400,000	4,300,000	1.0	279	1,176,480,000	3,741,000	1,023,537,600	1,419,000	388,238,400	NASS-ODAFF Oklahoma wheat variety survey
OR	885,000	878,000	1.8	301	472,128,000	544,360	292,719,360	435,488	234,175,488	OR Wheat Breeder (Robert Zemetra)
PA	165,000	145,000	1.8	294	75,400,000	130,500	67,860,000	21,750	11,310,000	VA breeder Carl Griffey
SC	235,000	220,000	1.4	244	77,539,000	110,000	38,769,500	33,000	11,630,850	Estimate of Wheat Breeder in neighboring state
SD	2,405,000	2,235,000	1.2	301	839,427,000	1,341,000	503,656,200	894,000	335,770,800	SDSU and NE wheat breeders
TN	420,000	340,000	1.7	250	145,656,000	102,000	43,696,800	51,000	21,848,400	Estimate of Wheat Breeder in neighboring state
TX	5,700,000	3,000,000	0.9	250	652,800,000	3,648,000	793,804,800	342,000	74,419,200	Wheat Breeders (Amir Ibrahim & Jackie Rudd)
UT	155,000	137,000	1.2	322	54,568,000	139,500	49,111,200	NA	NA	Estimate of wheat breeder in Utah (David Hole)
VT	280,000	240,000	1.8	257	109,200,000	216,000	98,280,000	36,000	16,380,000	VA breeder Carl Griffey
WA	2,210,000	2,175,000	1.8	305	1,216,694,000	1,305,000	730,016,400	108,750	60,834,700	2013 Washington Wheat Variety Survey
WV	8,000	4,000	1.8	257	1,820,000	NA	NA	NA	NA	NA
WI	265,000	245,000	2.0	277	138,731,000	NA	NA	NA	NA	NA
WY	150,000	120,000	0.7	279	22,800,000	116,000	17,632,000	-	-	Wyoming Agricultural Statistics 2012 & Robin Groose breeder
Total	55,456,000	48,740,000	1.5	280.0	17,753,950,523	32,678,564	11,021,040,978	9,464,717	3,323,641,077	
* d=durum, s= spring, w=winter				Extrapolation 100% acreage:		33,824,316	11,545,780,406	9,915,355	3,481,887,972	

Appendix II. Acreage and production from barley public varieties (and from varieties generated by MAS)

State	Acres planted	Acres harvested	Yield tons/ac	Production tons	Avg. Price per ton	Production value $	Acres public varieties	Value Pub var.	Acres var. with markers	Value var. with markers	Source
AZ	48,000	47,000	2.9	134469	196	26,402,000	NA	NA	NA	NA	
CA	120,000	80,000	1.5	119891	215	25,740,000	NA	NA	NA	NA	Lynn Gallagher barley breeder
CO	58,000	55,000	3.4	184332	248	45,664,000	NA	NA	NA	NA	
DE	38,000	34,000	2.3	77820	152	11,852,000	30,600	10,666,800	5,100	1,777,800	VA breeder Carl Griffey
ID	610,000	590,000	2.5	1462943	240	351,670,000	14,750	8,791,750	-	0	Idaho Barley Commission
KS	10,000	7,000	1.6	11253	220	2,478,000	10,000	3,540,000	-	0	Steve Baenziger
ME	17,000	16,000	1.6	26158	156	4,080,000	NA	NA	NA	NA	
MD	60,000	40,000	2.2	89373	152	13,612,000	36,000	12,250,800	6,000	2,041,800	VA breeder Carl Griffey
MI	11,000	9,000	1.3	11771	184	2,160,000	NA	NA	NA	NA	
MN	115,000	100,000	1.6	155313	235	36,480,000	86,000	31,372,800	-	0	MN barley breeder K. Smith
MT	900,000	790,000	1.4	1140872	233	265,875,000	237,000	79,762,500	120,000	40,386,076	NASS and information from D. Pauli/T. Blake
NY	10,000	8,000	1.3	10245	200	2,049,000	NA	NA	NA	NA	
NC	23,000	17,000	1.7	29183	150	4,391,000	15,300	3,951,900	2,550	658,650	VA breeder Carl Griffey
ND	1,060,000	1,010,000	1.7	1678747	240	403,546,000	397,940	158,997,124	-	0	NASS. Information from barley breeders.
OR	56,000	53,000	2.0	103978	229	23,850,000	37,100	16,695,000	5,300	2,385,000	
PA	65,000	53,000	1.9	98202	156	15,317,000	47,700	13,785,300	7,950	2,297,550	VA breeder Carl Griffey
SD	34,000	22,000	1.0	21580	209	4,514,000	NA	NA	NA	NA	
UT	44,000	26,000	2.2	56676	217	12,272,000	NA	NA	NA	NA	
VA	65,000	37,000	2.2	82670	139	11,529,000	33,300	10,376,100	5,550	1,729,350	VA breeder Carl Griffey
WA	185,000	175,000	2.0	343324	204	69,930,000	NA	NA	NA	NA	
WI	33,000	15,000	1.2	17984	207	3,729,000	NA	NA	NA	NA	
WY	75,000	60,000	2.4	145504	237	34,443,000	NA	NA	NA	NA	Robin Groose Breeder
Total	3,641,600	3,248,300	1.9	6,007,925	201	1,372,690,000	945,690	350,190,074	152,450	51,276,226	
					Extrapolation to 100% ac:		1,125,821	416,892,945	181,488	61,043,126	