COMPETITIVENESS AND OPPORTUNITIES OF U.S. MALTING BARLEY IN CHINA: 6-ROW MALTING BARLEY BREWING TRIALS FY 2009

For marketing purposes, malting barley is divided into two groups: two-row varieties, and six-row varieties. The two classes differ by kernel size, extract, protein, and enzyme levels. Minnesota and North Dakota are the top six-row malting barley producing states in the U.S. and in the 1990s exported malting barley to China. However, U.S. barley exports and market share have dropped substantially since then due to the spread of crop diseases in the Midwest and the suspension of U.S. barley export subsidies.

China is now the biggest beer producer and malting barley importer in the world, consuming 70% of the world's malting barley. Major malting barley suppliers to China are Australia, Canada and France. The first steps to promote U.S. malting barley in China would be to educate Chinese users about the characteristics of U.S. six-row malting varieties, and quantify the economic benefits. This project entailed cooperative brewing trials with food research labs in China using Minnesota and North Dakota six-row malting varieties as raw materials, and development of customized brewing procedures and recipes suitable for current mainstream brewing facilities in China.

FINAL REPORT

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MINNESOTA DEPARTMENT OF AGRICULTURE

U.S. Malting Barley in China
FY 2009 FSMIP grant 12-25-G-0891

For marketing purposes, malting barley is divided into two groups: two-row malting varieties, and six-row varieties. The two classes differ by kernel size, extract, protein, and enzyme levels. Minnesota and North Dakota are the top two six-row malting barley producing states in the U.S. and in the 1990s used to export malting barley to China. However, in late 1990s, the spread of crop diseases in the Midwest adversely affected the export market. At the same time, U.S. barley export subsidies were suspended. Consequently, U.S. barley exports and market share have dropped substantially since 1990s.

China, the biggest beer producer and malting barley importer in the world, consumes 70% of world malting barley. The major malting barley suppliers for this market are Australia, Canada and France. Barley in China has been considered a food and feed grain. Like wheat, barley was government controlled and monopolized by the China National Cereals, Oils and Foodstuffs Corporation (COFCO). The barley market competition is fierce with many domestic and global countries competing for the malting barley business.

The beer industry in China is booming. Beer was first introduced to China early last century, but the beer industry only began to expand about 15 years ago. In 1978, China only produced 40 thousand tons of beer. The beer production increased from 8 million tons in 1991 to more than 23 million tons in 2000. China's annual beer consumption per capita is about 18 liters, which is well below the world average. Today in China, there are 474 terrific and terrible breweries; there are only 44 breweries with production capacity over 100 thousand tons, which is about one-half of the total production.

The China beer industry requires 2.5 million tons of malt every year. There are 243 malting houses—20 of them have the annual capacity of more than 40 thousand tons. There are 101 breweries malting for their own malt. About one million tons of domestically-produced malting barley was easily consumed, and demand for the foreign barley increased dramatically. Due to high import tax, there is no substantial processed malt import.

Annual increase of beer production has slowed down from 20% to the most recent 8%. This is a very obvious indication that the industry has entered a period of restructure. There are too many brands of beer with very different tastes. Yanjing Beer in Beijing, Qingdao Beer in Shandong and Zhujiang Beer in Guangdong are taking over many small breweries. In the past two years, more than a hundred small breweries have been taken over. COFCO and Guangdong Enterprises are the biggest malt suppliers, and local government trade barriers are still very strong for the beer industry.

After thorough comparison between two-row and six-row malting varieties and associated costs, it was determined that for U.S. barley growers, there are more opportunities for six-row varieties in China market than two-row varieties. Therefore, the project focused on promoting six-row malting barley in China market.

The major trade barriers to exporting six-row malting varieties are: 1) Less understanding of six-row malting barley among Chinese users. The dominant concept they have is that two-row malting

barley has higher extract which can bring more economic benefit to breweries; 2) The limitation of existing malting and brewing facilities in China. Mainstream facilities in China are customized for two-row malting varieties; 3) Direct contracting process of U.S. barley growers to malt companies. Information gap between growers and Chinese buyers make both of them unwilling to take the risk of signing purchase contract before planting season while the delivery would be half a year later; and 4) Strong marketing promotions on two-row malting varieties by other suppliers such as Australia and Canada.

Goals and Objectives

To promote U.S. malting barley, the first step would be to help Chinese users to understand the characteristics of U.S. six-row malting varieties, and quantify the economic benefit they would have by using it. This project entailed cooperative brewing trials in China with qualified food research labs in China using Minnesota and North Dakota six-row malting varieties as raw materials, and development of customized brewing procedures and recipes suitable for current mainstream brewing facilities in China. Project objectives were to:

1. Categorize the opportunities and generate strategies.

Using available literature on malting barley, conduct SWOT analysis of U.S. six-row malting varieties, identify the strengths, weaknesses, opportunities and threats of exporting U.S. malting barley to China. Develop short-term and long-term marketing promotion strategies and work plans.

2. Conduct brewing trials to identify benefits to Chinese brewers by using U.S. six-row malting barley.

Cooperate with Chinese brewers and malting firms to conduct brewing trials using six-row malting barley provided by Minnesota Barley Research and Promotion Council and North Dakota Barley Council. Three major six-row malting varieties produced in the Midwest would be used in brewing trials, namely Robust, Tradition and Lacey. Evaluate the trial results from several factors including quality, brewing techniques, price, flavor of the finished product, the malting firm profits, and the changes in malting margins in comparison with two-row malting varieties.

3. Quantify the benefits to U.S. six-row malting barley growers by exporting products to China.

Estimate the potential demand of six-row malting barley of the targeted market. Determine what the potential cost would be to export this product to China, itemize costs, and what the overall welfare effects of expanded export markets for barley growers in Minnesota and North Dakota will be.

4. Publicize the findings.

Participate in malting and brewing conferences and workshops in China to disseminate the findings and encourage the interests from the private and public sectors in further understanding of U.S. six-row malting varieties.

5. Evaluate results and determine further steps.

Cooperate with China Alcoholic Drinks Association to conduct a post-study survey among major malting barley importers and users in China to determine effects of the brewing trials and its findings. This will show if there has been effect on their plans on raw material purchasing and new product development. Decide if further steps are necessary and outline what they should be.

Contribution of Project Partner
In-kind match from Minnesota Barley Research and Promotion Council consisted of technical support, salary and fringes of Director, staff salary time, fringes, travel, and indirect costs. An additional $4,000 was contributed to purchase malting barley for testing in China.

How the Project Was Approached
Minnesota Department of Agriculture and Minnesota Barley Research and Promotion Council personnel made six visits to the China National Research Institute of Food and Fermentation Industries' R & D Center of Brewing in Beijing. They struggled with language contract issues, samples for the trials, timeline of the trials, clarity of expected results, cost benefits, and administrative issues in paying for the study. They were fortunate on one of the trips to have Paul Schwarz of North Dakota State University (NDSU) Institute of Barley and Malt Sciences assist with technical areas of the malting trials. Jiang Junyang from the Ag Affairs Office of the U.S. Embassy assisted them twice on institute visits which helped immensely with technical translation issues. The U.S. malting information was promoted at three U.S. barley conferences in October. These one-half day U.S. barley seminars were unique due to location, but all had the same agenda (attached). The agenda included a farmer who grew barley, an executive of the barley check-off organization, a NDSU professor, and an industry presentation on commercial six-row malting by the Anheuser-Busch operations director. The first seminar in Beijing had 20 attendees: Beijing academia, barley traders, local beer technology staff, FAS personnel, and trade media.

The next seminar was in Qingdao with Tsingtao Brewery Company. They had the core purchasing and brewery R & D Center managers (8) and also about 25 of the research laboratory employees. The seminar was conducted at the Tsingtao research center in the morning and malt tours were given to the speakers in the afternoon. Tsingtao currently has 54 breweries and three malting plants in China and is regarded as the "national" brewery in China. The last barley seminar was in Shanghai and had 15 people from the local beer industry, brewing associations, malting companies, and the FAS-ATO.

Challenges and Opportunities

1. Finding the right partners who can deal with technical language issues is a challenge.
2. Paying contractors or amending contracts in China can be a bureaucratic nightmare, principally due to state government policies, paperwork requirements on signatures and translation issues.
3. Timelines on conferences need to be extended to allow for presentation preparation and local promotion. This was done on the second series of purchasing seminars vs. the first where we had more "control" of the agenda vs. the first where we used Cargill and a local Chinese university who all had their own agendas.
4. They did the conferences in four different locations in China: Wuxi, Beijing, Qingdao and Shanghai. This was great and we did receive several compliments for the in-country travel that was done.
5. The EMP project/grant was necessary to assist in the six-row publication findings and the promotion of U.S. barley. The project needs to be well communicated between FAS offices in both Beijing and Washington DC.
6. The industry needs to be engaged to continue to send samples and malt trial information to the malt and beer attendees of the conferences (follow-up), especially with Tsingtao Brewing Company in Qingdao who desires to purchase two varieties of six-row barley.

Recommendations for Current/Future Benefits Future Research/Next Steps
Currently, Tsingtao Brewery in Qingdao is testing two 6-row 2010 crop year varieties with the microbrewery. They will send the malt samples to the Dalian malt house to complete the tests after the Chinese New Year (February 2011). The next step would be to assist the Tsingtao central purchasing with a special import permit for the first commercial shipment of 480 metric tons.
We also should look at participating in the China Institute conference program in September 2011 with Paul Schwarz of NDSU. He has a phenomenal credibility with the industry technical people in China. The quoted cost to participate in this conference is 3,000 Euros.

Project Beneficiaries
China is the largest importer of malting barley and has seen tremendous growth in the building of malting plants. Canada and Australia are usually the top suppliers and they are struggling with necessary acreage and quality issues. The market is heating up and the opportunity is there "now" for Minnesota and North Dakota barley producers to export barley to China.

Attachments
Brewing Technology Center Report

Brochure on Minnesota and North Dakota Barley Production

Minnesota Agricultural Profile

U.S. Barley Seminar Bilingual Agenda

Powerpoint Presentations

U.S. Six Row Malting Varieties: Technical Considerations

6-Row Malting Barley Production in Minnesota and North Dakota

Barley Acquisition Programs

World's Largest Beer Producing Countries

The Report for the malting and brewing performances of American six-row barley

entrusted by Minnesota Department of Agriculture

BREWING TECHNOLOGY CENTER

CHINA NATIONAL INSTITUTE OF FOOD AND FERMENTATION INDUSTRIES

Table of Content

INTRODUCTION

Per contract #B35091 between the China National Research Institute of Food and Fermentation Industries and Minnesota Department of Agriculture. We should finish the work as followed:

1) Quality analysis of malting barley(three six-row barley varieties and one two-row barley variety for control), including normal analysis;

2) Analysis of Mycotoxins: the analysis should cover questions from breweries on barley quality and Mycotoxin contamination, and meet government regulatory standards on malting barley;

3) Micro-malting using three six-row barley varieties; conduct analysis and evaluation of malt quality of each variety

4) Pilot-scale malting: Two batches pilot-scale malting for each variety, and conduct analysis for each pilot-scale malting;

5) Brewing test: design suitable brewing test to evaluate the benefit breweries will get because of using six-row varieties, conduct analysis and evaluation of each brewing test.

Now we have finished the whole work, the test results of term 1-4 were already sent to Minnesota Department of Agriculture. The brewing test result was in the attachment files(see Report R-BC-F10-01: beer test result).

The project purpose is to compare the quality of the American six-row barley with the quality of two-row malting barley in malting and brewing, evaluate the possible profit margin of the American six-row barley.

Based on the whole test., one of the most important findings is that the American six-row barley (Lacey、Stellar and Tradition) could give high yield of extract with shorter germination period than control. These malting barley varieties, such as Lacey, Stellar and Tradition, could replace part of the two-row malting barley without significant influence on the beer quality.

MATERIALS AND METHOD

Barley samples

The American six-row barleys used in this study were supplied by the Minnesota Department of Agriculture. Control variety sample is supplied by the Beijing Yanjing Brewery Co. LTD. Others were obtained from France, Gansu and Heilongjiang in China. The detailed information of these barley varieties are listed in below table.

The properties of these barley varieties are summarized in table 1. Standard methods(National standard of People's Republic of China for Malting barley GB/T7416-2008, Barley malt QB/T1686-2008, Beer GB4927-2008), EBC method for β-glucan and friability and in some case

the methods developed for flavor (BREWING TECHNOLOGY CENTER ,China National Research Institute of Food and Fermentation Industries), were employed in barley, malt and beer analyses.

Sample	Type	Source
LACEY	Six-row	United States
STELLAR	Six-row	United States
TRADITION	Six-row	United States
CONTROL	two-row	Australia
SEBASTIAN	two-row	France
CERVOISE	Six-row	France
GANPI-5#	two-row	China, Gansu
KENPIMAI-9#	Six-row	China, Heilongjiang

Flavor analyses method

1 The chromatography system and regents

This work was performed on a Perkin Elmer GC auto system.XL， with flame ionization detector. Chromatography column stainless steel packed with DB-WAX (0.53mm×30m), autosampler for the gas chromatoghraph and Totalchrom 6.30 work station.

Flavor standards are high pure regents from sigma， with mother solution concentration is 100mg/L， under 2-8℃.

2 Chromatography condition

Transfer beer sample 5ml into HS-bottle with 55℃ for 30min.

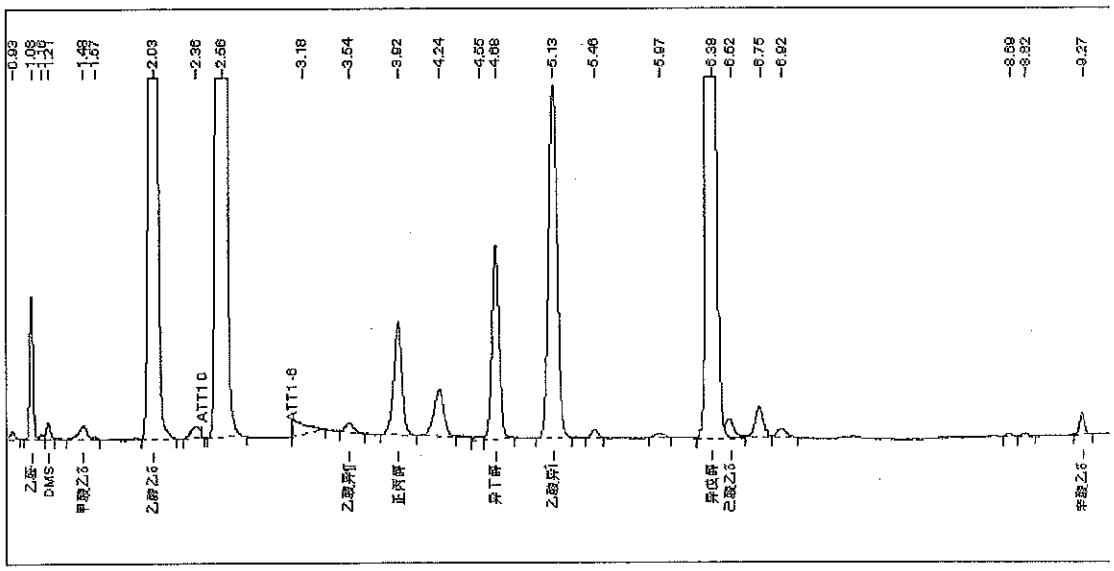
Carrier gas: Nitrogen

Carrier gas flow rate： 8 ml / min；

Injector temperature: 200℃ detector temperature： 230℃

Temperature program：hold 3min at 35℃，increase to 60℃ at the rate of 10℃/min，increase to 120℃ at the rate of 20℃/min，20℃/min 升温到，increase to 220℃ at the rate of 40℃/min.

Fig1 chromatogram of 11 flavor standards solution



Note: the standard from the left to the right is acetaldehyde, Dimethyl Sulfide, Ethyl Acetate, Isobutyl Acetate, n-Propanol, Isobutanol, Isoamyl Acetate, Isoamyl Alcohol, Ethyl hexanoate, Ethyl Octanoate

Organic acid analyses method

1 The chromatography system and regents

This work was performed on a Dionex (Sunnyvale, CA) ICS-3000 system.， with EG40 eluent generator, conductivity detector and Chromeleon 6.80 work station, Ionpac AS11-HC analysis column(250 mm×4 mm), Ionpac AG11-HC guard column(50 mm×4 mm); ASRS-ULTRA anion suppressor; 0.45μm filtration membrane (Milipore Co.);

ultra pure water system(Pine-Tree Co.), KQ100-D Eultrasonic cleaner (Kunshan city Eultrasonic cleaner Co.).

Organic acids and anions standards are high pure regents from sigma, with mother solution concentration is 1000mg/L， under 2-8℃. Ultra pure water system was used to provide 18.3 MΩ·cm water.

2 Chromatography condition

Eluent: EG auto generate gradient eluent. Flow rate: 1.0 ml / min;

suppressor regenerate mode: external water;

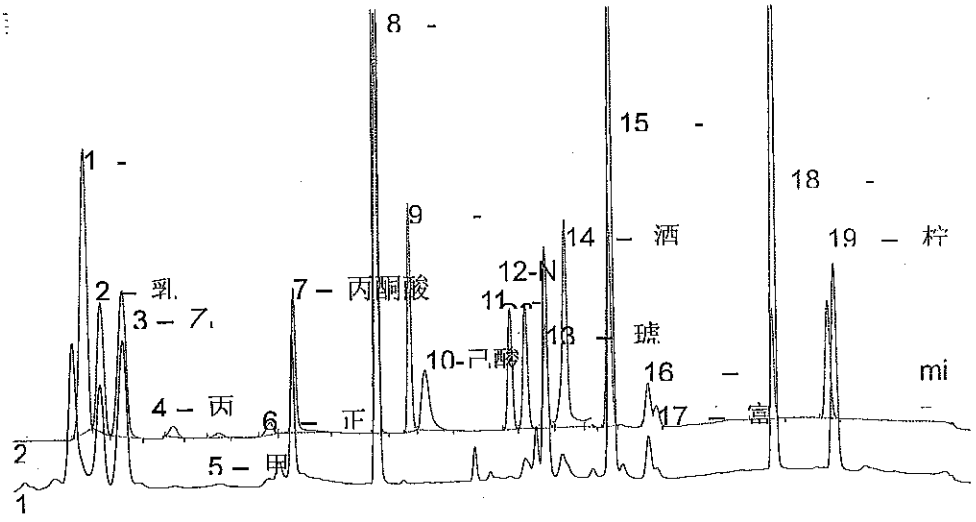
inject volume: 25μL.Quantification with peak area.

t/min	KOH concentration (mmol/L)	t/min	KOH concentration (mmol/L)
0.00	0.80	16.00	0.80
29.00	16.50	35.00	20.00
39.00	35.00	45.00	35.00
45.10	50.00	47.10	50.00
47.20	0.80	59.00	0.80

3 sample handling

Twenty milliliters of beer was added in flask , and which was in eultrasonic cleaner for about 30 minutes, 1 ml of the solution in the flask was diluted 10-fold in water. The dilution was filtered through a 0.45 μm nylon filter, prepared for analysis.

Fig.1 chromatogram for organic acid of standard and beer sample



Note: the blue is the chromatogram of standard; the dark is the chromatogram of beer.

The organic acid of peak2, 3, 7 and peak19 were analyzed, that is lactic acid, acetic acid, pyruvic acid and citric acid.

Sensory evaluation

A trained panel with 6 assessors evaluated the beer samples from the pilot brewery. Evaluation was made in terms of odor, taste and body. The aroma includes four different characteristic terms such as fruity, hoppy, high alcohol, sulfury. The taste term consists of sweetish, sour, astringent, bitterness. The body is composed of harmony, fullness, and watery. Each assessor give the beer sample score based on every term score and a full description for each sample (see table 2).

Then the sensory evaluation result could be concluded.

Malting of barley

Malting of barley was conducted in the micro-malting plant (BAMD-8050 FREISING, WEST GERMANY). The below malting procedure was used in this study.

Micro-malting procedure 1:

Steeping:

Sampled was steeped at 15℃ for 5h, allowed 12h air rest, followed by 5h water steep（total time,22h）

The target Steep-out moisture: 44-45%

If the target couldn't be reached, the wet time would be increased.

Germination

The total germination time: 96h

12-13℃ during the first day; water sprinkling 0.5h/12h.

12-13℃ during the second day; water sprinkling 0.5h/12h

12-13℃ during the third day; water sprinkling 0.5h/12h

12-13℃ during the forth day. without sprinkling of water

During the germination, keep the air humidity at 90%;

Kilning

The germinated sample were kilned using the followed protocols:

50℃ 16h; 60℃ 1h ; 70℃ 1h; 80℃ 5h.

Micro-malting procedure 2:

Almost the same with the micro-malting procedure1, but the moisture target after the first steeping stage must be reached to the 35%. So the steeping protocol was a slight adjusted as followed:

Steeping

Sampled was steeped at 15℃ for 6h, allowed 12h air rest, followed by 5h water steep（total time,23h）

Germination

For more modification of the β-glucans, the germination protocol was adjusted as followed:

13℃ during the first day; water sprinkling 0.5h/6h.

14℃ during the second day; water sprinkling 0.5h/6h

15℃ during the third day; water sprinkling 0.5h/12h

16℃ during the forth day. with no sprinkling of water

During the germination, keep the air humidity at 90%;

Kilning

The kilning procedure is the same as the micro-malting procedure 1

Pilot-malting procedure 1:

Steeping

The following steeping procedure was adopted:

5.30h wet/12h dry followed by 3h wet. Wet or dry temperature was 18℃

During wet steeping, the aerations must be kept; during the air rest, the exhausting air must be kept.

Germination

The following germination procedure was adopted:

Germination temperature: 13～20℃

Germination total time:84h,

Continuous ventilation during germination

Specific time and frequency for replenishing water depends on the growth and moisture of green malt.

Kilning

Withering stage (45～65℃),9～13h

Drying stage (65～75℃),3h

Kilning stage (75～84℃),2h

Cooling stage(84℃～room temperature), 40-50minutes.

De-root by hand to give finished malt.

Pilot malting procedure 2

All the same as the pilot malting procedure 1, but the slight modification was made as followed:

Steeping

6.30h wet/12h dry followed by 3h wet.

Germination

Germination total time: 96h.

Pilot malting procedure for control

The procedure is the same with the pilot malting 1, but the total germination time is 120h.

10^0P beer procedure

Pilot brewing was conducted in the micro-brewery (BAMD-8050 FREISING, WEST GERMANY). The below brewing process was used in this study.

brewhouse process:

1 mash tun capacity 100L ： Feed in 13.0Kg， Total water volume 52L. Ratio of raw material/water 1： 4)

2 malt mill： roll gap 0.8-1.0mm

3 rice mill: roll gap 0.5mm(mill two times)

4 The brewhouse process and fermentation procedure of different batch is almost the same but the Ratio of raw material. The ratios of different batches are listed in the below table.

mash recipe for mash batch 1(control)

Raw material	Ratio of raw material	Weight(Kg)	Preset water（L）	Ratio of raw material/water
Australia barley malt	60%	7.8	30	1：3.8
Rice from northeast in China	40%	5.2	22	1：4.2

proportions of raw material for different mash batches

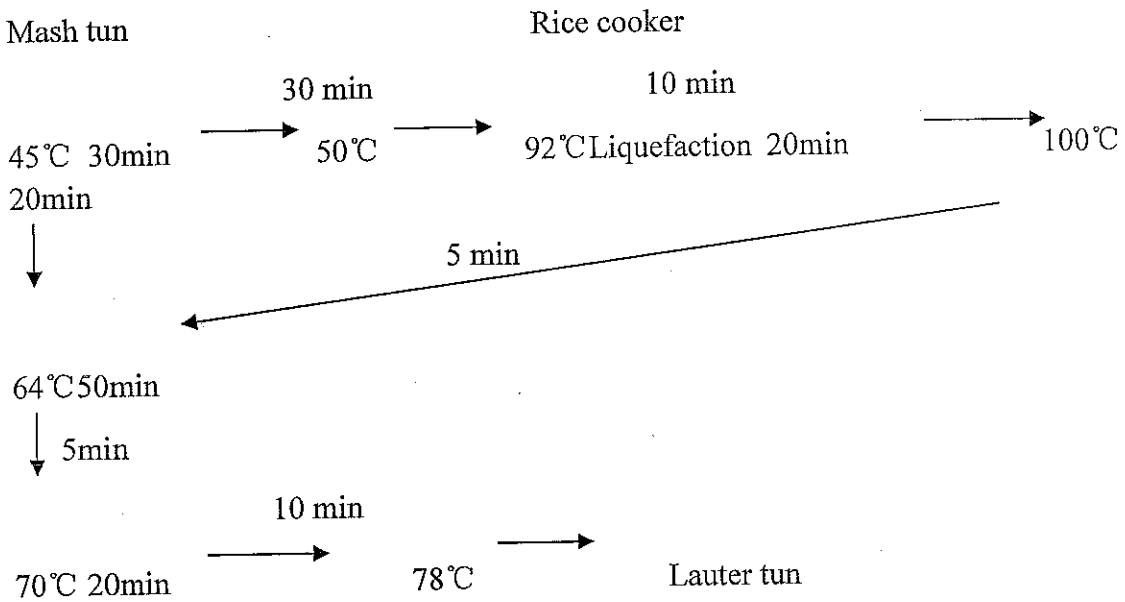
Raw material	1	2	3	4	5	6	7	8
Australia barley malt	60%	30%			30%		30%	
lacey		30%	60%	50%				
Stellar					30%	60%		
Tradition							30%	60%
Rice from northeast in China	40%	40%	40%	50%	40%	40%	40%	40%

2、Ingredients employed

	Mashing Tun	Rice Cooker	Boiling Kettle
Calcium chloride	6g	4g	--
Gypsum	6f	--	
Lactic acid	4.7ml	--	--
Beer complex enzyme	1ml		
α -amylase	--	1.8ml	--
hop	--	--	Hop"Hersbruck" 50g

note：1add hop 50g at 5 minutes before boiling finished

3、mashing diagram



Note:

① sparging two times, cut off volume is 108-110L。

② the wort boiling should be finished in 60minutes and total evaporation keep in 10L.

③ the whirlpool time is 30minutes.

④ The hot wort should be cooled down to 8-9℃， then be aerated with sterile air and make the DO lever to 8-10ppm.

Fermentation process:

1 Pitching Rate: $1.2\times10^6\sim1.5\times10^6$

Pitching temperature: 8～9℃

2 temperature naturally rises to 10.0℃（±0.2℃） and conduct primary fermentation;

3 pressure rises after apparent gravity arriving 2.5-2.8^{0}P and keep the pressure at 0.08Mpa;

4 crop yeast after pressure rise and remove the yeast every 2-3days

5 remove all of the yeast when diacetyl is decreased to or below 0.08ppm.

RESULTS AND DISCUSSION

General properties of the barley samples

Table 2 shows the different samples of barley used in this study. These samples include the six-row barley and two-row barley from different country. The requirement of National standard for the first grade malting barley is also listed in the table 21.

The results in table 2 show that the moisture content of the three American six-row barley (Lacey, Stellar, Tradition) are very low, but moisture content of France barley sample are a little bit high. All sample have good germination (4ml) and sensitive test result but the France sample which have not very good germination (8ml).

The protein content of the three American six-row barley (Lacey, Stellar, Tradition) is moderate，a little bit higher than the two-row barley, also the six-row France barley, but it still satisfy the requirement of the China National Standard (GB/T7416)for the six row malting barley.

The 1,000 kernel weight and sieving test of the three American six-row barley (Lacey, Stellar, Tradition) is also in the first grade of GB/T7416. But The 1,000 kernel weight and sieving test or the Australian two row barley, as the second grade commercial barley, is an exception.

From the above all, it could be concluded that the quality of the three American six-row barley sample (Lacey, Stellar, Tradition) is good and

meet the first grade demand of GB/T7416.

Malting performance

From the result of micro-malting 1, it could be found that there is not significant difference between lacey, Stellar, Tradition and the control in terms of fine extract, Free amino and Protein modification. But it shows difference in terms of the viscosity, friability, Fine-Coarse Difference and β -glucans. Especially variety tradition shows the highest lever of Fine-Coarse Difference, viscosity and β -glucans, the lowest lever of friability (see table 3).

Based on the micro-malting 1 result, Adjustment was made in the micro-malting 2. That is to make minor adjustment on the steeping process and gradually improved germination temperature. It facilitates the modification of the six-row barley. The result of the viscosity, friability, Fine-Coarse Difference and β -glucans for six-row barley gets better. Even though the Fine-Coarse Difference and β -glucans of tradition is still not very satisfactory, but better than the result in the micro-malting 1.

During the pilot-malting 1, the steeping and germination temperature was increased. But the steeping target moisture was not enough reached. It was shown that acrospire of the six-row barley grow faster than the control variety. The germination period reduced to 84h. From table 3, it

was found that the modification of variety tradition was better than the result in micro-malting, even though the result of variety lacey and stellar were not perfect.

The pilot malting 2 was modified based on the condition of the pilot malting 1. It looks that the final malt result of the American six-row barley during this procedure were perfect. But the Acrospire of variety tradition had a little bit over-growth (Acrospire Growth Rate(>1) is over 10%).

On the whole, the malting performance of the six-row barley (Lacey, Stellar and Tradition) were satisfactory on the 44-45% target Steep-out moisture and over 15℃ germination temperature for 96h. For variety tradition, the malt modification is not perfect. It may be related to germination non-homogeniety enough.

Brewing performance

Pilot brewing with 8 batches were conducted in the pilot brewery of China National Institute of Food and Fermentation Industries. The brewhouse process and fermentation procedure of different batch is almost the same but the Ratio of raw material for each brewing test.

The physical and chemical character and flavor and taste compounds were analyzed. For the table 8, we could find all the result of these

batches sample satisfied the requirement of the National standard of PRC （GB4927-2008）. All the flavor and taste result of these batches sample were in the range of normal beer.

But from the brewhouse record data (table 5), It would be found that the net sparging time of batch 4 is much longer than other batches. The sensory test result also shows that the lowest lever of the batch 4. Therefore the same recipe for variety stellar and tradition was not adopted.

From the sensory result (see Report R-BC-F10-01: beer test result), it could be found that there is some difference of each batch and variety. Especially the adjunct ration has a significant affection on the tasting result. There was also some difference between the two-row barley and six-row barley on tasting. Perhaps more studies should be done on the impossible factor.

Profit margin evaluation for American six-row barley

According to the result of pilot-malting, the yield for control variety is 84.5%; for lacey is 85.2%; for stellar 88.8%; for tradition 81.0%. So the average yield of six-row barley is 85%. It's amazing result that the yield of six-row barley a little bit higher than two-row barley.

Because the CIF price for barley is influenced by a lot factors, it is hard to

give the exact price for the six-row barley we used in the studies. But the price of control variety is clear and the price of France six-row barley in the studies is the same with the control variety. We assumed that the price of American six-row barley in this study is the same. That is RMB2000yuan per ton.

As we known that the production cost of control variety is about 800yuan per ton. The profit margin is 100yuan per ton.

Then the control variety malt could be bought at over 2900yuan per ton.

From the first, we know that the yield of the barley we used, then it could infer malt yield from the barley quantity, that is

From 1000 Kg Two-row control barley, we could get malt:

1000×84.5%=845Kg

From 1000 Kg six-row control barley, we could get malt:

1000×85%=850Kg

For 1000 Kg, we could get more six-row barley malt:

850-845=5(kg)

As we known the price of the six-row France barley malt is 2800yuan/ton. Then, we could infer that for 1000 six-row American barley , we could sold 5kg more malt then the control. It equal to 5×2.8yuan=14yuan.

On the basis of the pilot malting result, the total germination time is one day shorter than the control. That mean it will save one day cost for every malt batch.

The production cost is 800yuan. It equals to save money:

800÷7(day)≈120yuan

Then the production cost for each ton is 800-120-14=666yuan

If the sale price for six-row barley malt is the same with the six-row France barley, that is 2800yuan/ton, then the profit margin for each ton of six-row American barley variety is

2800-2000-666=134yuan.

If the CIF price is more competitive than the price we mentioned above, then it would has more profit margin. But if the quality is not as good as the sample in this study, then the profit margin would be narrow.

CONCLUSION

In general, the quality of the six-row American barley is perfect, and satisfy the requirement of the China National Standard (GB/T7416).

It seemed that the six-row American barley are easy to develop higher extract. But the endosperm modification of these barleys on normal malting procedure is not satisfied. Through the target Steep-out moisture

and over 15℃ germination for 96h, the modification of these barley gets better. For variety tradition, it may be more important to get enough germination homogeniety.

The brewing data for these barley was not bad. But it is not better than the control variety in the sensory test. It seemed that brewing with two-row barley malt more benefit the beer flavor.

The profit margin of the six-row American barley malt is not bad based on the commercial malt price in China this year and the good quality of the sample we got.

Table 1 Sensory test record form

	Odor				Taste					Body					comments	Others	Total score
	fruity	hop aroma	high alcohol	sulphury flavor	sweetish	sour	astringent	bitter	after bitter	carbonic	harmony	clear	fullness	watery			
1																	
2																	
3																	
4																	
5																	

note：1、the perfect score is 9 for each term, the reference standard is as followed

0—not exist、2—very weak、3.5--weak、5.5--medium、7--strong、9—very strong

2、if there is any other flavor which not included in the form, note it in the "others", and give the related scores.

Table 2 the general properties of the barley sample

sample	moisture	protein	Germination (4ml/72 hrs)	Germination (4ml/120 hrs)	Germination* (8ml/120 hrs)	1, 000-Kernel weight	Sieving test(under 2.2mm screen)	Sieving test (under 2. 2mm screen)
six row barley (France)	12. 2	10. 5	97	98	12	40. 2	96. 6	0. 4
six row barley (Heilongjiang)	11. 1	11. 9	100	100	3	31. 4	93	0. 7
Lacey	8. 9	11. 3	100	100	1	36. 9	93. 3	0. 1
Stellar	8. 9	11. 1	100	100	1	37. 6	95. 9	0. 1
Tradition	8. 8	11. 3	100	100	0	39. 5	98. 9	0. 0
two row barley (Australia)	10. 3	10. 1	100	100	3	33. 7	86. 2	3. 2
two row barley (France))	12. 5	9. 5	99	99	12	40. 8	95. 1	1. 3
two row barley (Gansu)	11. 7	9. 6	100	100	0	43. 3	98. 8	0. 1
GB/T7416-2008 (first grade for six-row barley)	≤12	10-12. 5	≥95	≥97	≥90	≥37	≥80	≤4

***note this term was belong to the old national standard, now it was canceled from the GB/T7416-2008**

Table 3 malt from micromalting analysis result

sample	test batch	moisture	Fine Extract	FAN	Kolbach Index	Visco sity	β -glucan	Color	Friabili ty	Fine-Coarse Difference	Acrospire Growth Rate(1/2~1)
Lacey	micro-	4.7	80.0	188	43.3	1.65	236.0	3.0	82.0	1.9	81.0
Stellar	malting	4.8	81.1	186	44.4	1.70	221.0	3.0	88.0	0.7	88.0
Tradition	-1	5.3	81.1	187	45.2	1.76	483.0	3.5	70.0	3.5	78.0
control		4.4	81.3	179	44.4	1.54	267.0	4.0	96.0	0.9	88.0
Lacey	micro-	5.6	80.2	201	46.4	1.53	127.0	3.0	87.0	0.8	85.0
Stellar	malting	5.6	82.2	209	47.2	1.55	69.0	3.0	87.0	1.0	89.0
Tradition	-2	4.7	80.6	199	46.0	1.69	456.0	3.0	80.0	2.7	77.0
control		5.7	82.0	186	47.4	1.46	54.0	4.5	95.0	0.9	90.0

Table 4 malt from pilot-malting analysis result

sample	test batch	moisture	Fine Extract	FAN	Kolbach Index	Viscosity	β-glucan	Color	Friability	Fine-Coarse Difference	Acrospire Growth Rate(1/2~1)
Lacey	pilot-malting -1	4.8	79.9	186	46.7	1.63	240.0	3.5	82.0	2.2	86.0
Stellar		4.8	81.0	173	47.6	1.70	361.0	3.0	85.0	2.0	87.0
Tradition		4.9	80.9	163	46.1	1.83	393.0	3.0	81.0	2.2	80.0
control		4.4	80.3	186	47.5	1.58	195.0	3.3	98.0	0.5	92.0
Lacey	pilot-malting -2	4.5	80.3	181	46.9	1.52	104.0	3.5	83.0	2.0	90.0
Stellar		4.2	81.7	219	46.3	1.54	54.0	3.0	95.0	0.8	94.0
Tradition		5.5	80.5	194	46.2	1.49	257.0	3.0	88.0	1.5	89.0
control		3.9	79.5	169	45.7	1.50	129.0	3.7	98.0	0.7	94.0

Table5 brewhouse record

Mash batch	Time of mash in	Time of mash off	Time of vorlauf	Runoff time	Net sparging time (min)
1	10:35	10:42	10:55	12:03	68
2	10:30	10:37	10:55	12:04	69
3	10:30	10:37	10:50	11:59	69
4	10:35	10:42	10:56	12:27	91
5	10:15	10:23	10:37	11:46	69
6	10:10	10:18	10:33	11:36	63
7	10:08	10:15	10:32	11:40	68
8	10:19	10:27	10:45	11:55	70

	Wort gravity（% by wt 20℃）	Specific gravity（ 20℃）	PH	Total acid（ml/100ml）	α -amino nitrogen (mg/100g)
1	9.85	1.03940	5.61	0.85	153
2	9.81	1.03925	5.68	0.81	157
3	10.09	1.04038	5.34	1.12	163
4	10.43	1.04180	5.59	0.88	158
5	10.10	1.04046	5.58	0.97	178
6	9.96	1.03989	5.58	1.02	171
7	10.22	1.04095	5.32	1.28	163
8	10.11	1.04047	5.25	1.24	168

Table 6 Flavor analysis result

flavor compounds	1	2	3	4	5	6	7	8	normalrange in beer	threshold	flavor in beer
Acetaldehyde	3.0	2.7	2.9	5.8	7.3	11.4	7.2	9.5	2.0～20	25.0	Green Leaves，Fruity
Dimethyl Sulfide	0.05	0.07	0.06	0.08	0.05	0.07	0.07	0.09	0.01～0.25	0.05	Cooked Vegetable(onion)
Methyl Acetate	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.1	0.6-12	150.0	Light Estery,fruity,solvent
Ethyl Acetate	12.3	14.8	15.3	12.6	18.2	17.8	16.2	15.4	8～42	33.0	Solvent,fruity,Sweetish
Isobutyl Acetate	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.01-0.2	1.6	Banana,Sweet
n-Propanol	16.9	11.2	11.1	11.3	9.3	9.4	8.6	8.1	5～15	800.0	Alcohol
Isobutanol	13.8	13.5	12.2	12.7	11.1	11.0	9.7	8.5	10～12	200.0	Jalcohol
Isoamyl Acetate	1.6	1.8	1.6	1.6	2.6	3.0	2.1	2.3	0.6-4.0	1.6	Banana,apple,solvent
Isoamyl Alcohol	63.6	57.6	60.9	64.5	66.6	64.3	63.1	54.9	30～70	70.0	Alcohol,banana, Sweetish
Ethyl hexanoate	0.13	0.14	0.13	0.17	0.19	0.21	0.21	0.22	0.1-0.5	0.23	Fruity,sweetish,
Ethyl Octanoate	0.19	0.25	0.31	0.44	0.48	0.57	0.26	0.45	0.1-1.5	0.50	Fruity

Table 7 Organic acid analysis result

	1	2	3	4	5	6	7	8	Range in super premium beer	threshold	Flavor in beer
Lactic acid	96.6	91.4	71.3	119.7	99.5	108.9	91.7	82.2	61-100ppm	400.0	Acid
Acetic acid	90.2	97.7	72.3	104.5	129.8	130.2	103.0	93.3	50-147ppm	175.0	Acid
Pyruvic acid	67.6	79.5	53.1	71.0	53.3	51.9	76.6	55.1	48-87	300.0	Acid, Salty
Citric acid	116.3	131.7	95.8	149.1	128.3	123.7	130.9	106.0	125-225	125-225	Acid

Table 8 physical and chemical result of final beer

	1	2	3	4	5	6	7	8	GB4927-2008 as reference
Ethanol(%,Vol)	3.37	3.44	3.56	3.71	3.66	3.54	3.59	3.44	≥3.3%vol
Real gravity(%by wt)	3.09	3.13	3.02	3.14	2.99	3.22	3.208	3.13	
Original gravity(%by wt)	9.71	9.88	9.99	10.39	10.16	10.15	10.23	9.88	allowed -0.3errow
Real degree of fermentation(%)	69.2	69.40	70.93	71.00	71.70	69.44	69.81	70.23	≥65%
PH	4.17	4.18	4.20	4.22	4.28	4.30	4.41	4.33	3.9-4.5
total acid(ml/100ml)	1.51	1.80	2.30	1.75	1.83	2.08	1.81	1.86	≤2.2ml/100ml
Diacetyl (mg/L)	0.06	0.06	0.05	0.03	0.02	0.01	0.04	0.04	≤0.1mg/L

Minnesota Barley Research & Promotion Council

2601 Wheat Dr.
Red Lake Falls, MN 56750
USA

Phone: 011-86-218-253-4311

North Dakota Barley Council

505 40th St. S.W. Suite E
Fargo, ND 58103
USA

Phone: 011-86-701-239-7200
Fax: 011-86-701-239-7280
www.ndbarley.net

Institute of Barley and Malt Sciences

Providing reliable, high-quality, targeted research and education for U.S. barley producers and domestic and international malting and brewing industries at a single site.

NDSU 7670 PO Box 6050
Fargo, ND 58108-6050
USA
Phone: 011-86-701-231-7973
Fax: 011-86-701-231-8474
www.ag.ndsu.edu/ibms

The purpose of the IBMS, which is a multi-state, industry and research organization, is to provide education outreach and research for all stakeholder groups with the goal of enhancing collaborative efforts among barley producers, domestic and international consumers of U.S. malting barley, and U.S. barley scientists. The interdisciplinary organization of the IBMS reflects the fact that barley, malt and beer quality are influenced by a combination of genetic, environmental and technological factors

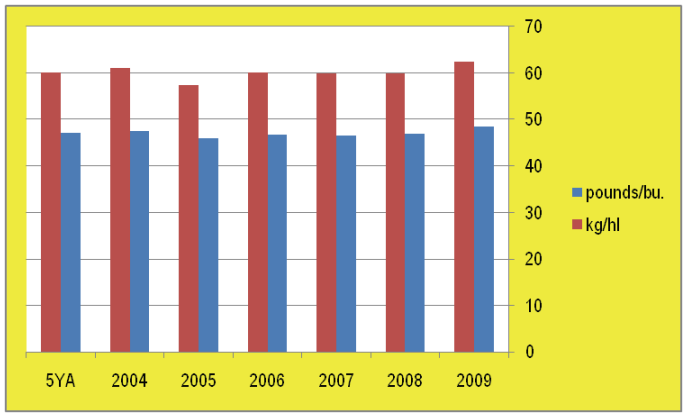
North Dakota Barley Council

Minnesota Barley Research & Promotion Council

Institute of Barley and Malt Sciences

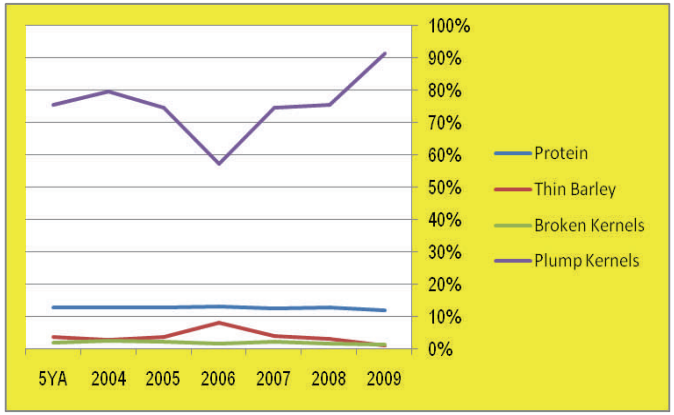
Estimated 2009 Production			
Variety	Percent	Type	Use
Tradition	46.00%	6 row	Malting
Lacey	16.40%	6 row	Malting
Stellar-ND	4.00%	6 row	Malting
Conlon	17.70%	2 row	Malting
Legacy	2.00%	6 row	Malting
Robust	3.40%	6 row	Malting
Rasmusson	0.70%	6 row	Malting
Haybet	2.90%	2 row	Feed
Logan	0.30%	2 row	Feed
Pinnacle	0.70%	2 row	Malting
Bowman	0.20%	2 row	Feed
Stark	0.30%	2 row	Feed
Conrad	0.30%	2 row	Malting
Hays	0.20%	2 row	Feed
Other	7.10%	NA	NA

Test Weights of 2009 6-Rowed Barley in North Dakota



Summary of 2009 North Dakota Barley Production	
Area Planted	1,210,000 acre (489,680 hectares)
Area Harvested	1,140,000 acres (561,352 hectares
Yield	70 bushels/acre (3,763 kg/hectare)
Production	79800000 bushels (1,737,458 MT)

Quality Factors in 2009 6-Rowed Barley in North Dakota



Estimated 2009 Production		
Variety	Bushels	Metric Tons
Tradition	36,708,000	799,231
Lacey	13,087,200	284,943
Stellar-ND	3,192,000	69,498
Conlon	14,124,600	307,530
Legacy	1,596,000	34,749
Robust	2,713,200	59,074
Rasmusson	558,600	12,162
Haybet	2,314,200	50,386
Logan	239,400	5,212
Pinnacle	558,600	12,162
Bowman	159,600	3,475
Stark	239,400	5,212
Conrad	239,400	5,212
Hays	159,600	3,475
Other	5,665,800	123,360

MINNESOTA DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICES

Minnesota Agricultural Profile

美國明尼蘇達州農業簡介

Population:	5.2 million
Total Land Area:	79,289 square miles
Agricultural land:	27 million acres (53% total land area)
Number of Farms:	79,000
Average Farm Size:	332 acres
Agricultural Sales:	$13 billion (2007)

Major Crops: corn, soybeans, sugar beets, wheat, potatoes, hay, sweet corn, edible beans, green peas, barley, sunflowers, and oats.

Major Livestock Products: Hogs, dairy, beef, turkey, and chicken.

Agricultural Processing: Meat, dairy, poultry, cereals, vegetables, soybean and corn processing, snack food, canned, frozen, and dehydrated food, beverages, food ingredients, and bio-fuels.

Agricultural Exports: Soybeans, corn, soybean meal and oil, red meat, live animals, wheat, dairy, poultry, feed, processed vegetables, hides & skins, sunflower seeds and oil, and planting seeds.

Agricultural Imports: Seafood, fruit, vegetables, rice, tree nuts, spices, tea, and snack foods.

Minnesota is the 6th largest agricultural producer and 7th largest agricultural exporter in the U.S. Each Minnesota farmer supports 128 people, 94 Americans and 34 in other countries.

China is the 3rd largest export market for Minnesota's agricultural and food products. We look forward to continued growth in our trade relations.

明尼蘇達州位于美國中北部，與加拿大接壤。全州人口520萬，土地面積20多萬平方公里，農田面積一千一百萬公頃。全州有79,000個農場，農場平均面積134公頃。2007年農業總收入達130億美元，是美國第六大農業州。

主要農作物包括：玉米、大豆、甜菜、小麥、土豆、苜蓿、甜玉米、豆類、葵花子、燕麥和大麥。畜牧包括：豬、奶牛、肉牛、火雞和肉雞。

明尼蘇達州的現代化食品和肉類加工業馳名全美。加工產品包括：肉類、乳制品、糧食及油料作物、冷凍食品、脫水食品、小吃、方便食品、罐頭、飲料、食品配料等等。另外，本州的玉米乙醇、大豆柴油及生物能源的生產也在美國占領先地位。

明尼蘇達州是美國第7大農產品出口州，2008年出口總額達到55億美元，為歷史最高水平。出口產品包括：大豆、玉米、肉類及牲畜、小麥、乳制品、飼料、家禽產品、加工蔬菜、獸皮、種子、油脂、葵花子、以及種類繁多的食品。明尼蘇達州最大的出口市場是：墨西哥、日本、中國、加拿大、台灣和韓國。

明尼蘇達州的進口產品是：海產品、水果、蔬菜、大米、乾果、香料、茶和小吃食品。

中國是明尼蘇達州第三大出口市場。我們希望與中國發展農業貿易和合作關係。如需明尼蘇達農業和食品詳細信息，請按如下地址與我們聯繫。歡迎您訪問明尼蘇達!

美 國 明 尼 蘇 達 州 農 業 廳

Minnesota Department of Agriculture

地址: 625 North Robert Street, St. Paul, MN 55155 U.S.A.

電話: 651-201-6000 傳真: 651-201-6114 網址: *www.mda.state.mn.us*

Chinese 2009

Minnesota and North Dakota Malting Barley Supplier List

Americas Malt (Cargill)
PO Box 5724
Minneapolis, MN 55440-5724
Tel: 1-952-742-5646 Fax: 1-952-742-5050
Internet: www.Cargill.com

Busch Agricultural Resources, Inc.
PO Box 427
West Fargo, ND 58078
Tel: 1-701-282-5752 Fax: 1-701-282-6260
Tel: 1-612-341-2326 Fax: 1-612-341-2137

Cenex Harvest States
PO Box 64089
St. Paul, MN 55164-0089
Tel: 1-651-306-6156 Fax: 1-651-306-6570
Internet: www.harveststates.com

ConAgra Grain Companies
400 4th Street #850
PO Box 15083
Minneapolis, MN 55415

Malteurope
3830 West Grant Street
Milwaukee, WI. 53201
414-649-0242

Minnesota Barley Research & Promotion Council
2601 Wheat Drive
Red Lake Falls, MN 56750
Tel: 218-253-4311ex18 Fax: 218-253-4320

North Dakota Barley Council
505 40th St SW, Suite E
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800 West First Avenue
Shakopee, MN 55379
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Minnesota, U.S.A.

美國明尼蘇達州地理位置

MINNESOTA DEPARTMENT OF AGRICULTURE

明尼苏达州农业厅

U.S. Barley Seminar

美国大麦研讨会

Mon, Oct. 25, 8:30 a.m. to lunch — Beijing, #10-5927-8888

10 月 25 日，星期一，早上 8:30——北京，#10-5927-8888

Beijing Marriott Hotel Northeast
26A Xiao Yun Road, Chaoyang District, Beijing
北京海航大厦万豪酒店
北京朝阳区，霄云路甲 26 号

Fri, Oct. 29, 8:30 a.m. to lunch — Shanghai, #21-6882-8888

10 月 29 日，星期五，早上 8:30——上海，#21-6882-8888

Pudong Shangri-La Hotel, Shanghai
No. 33 Fucheng Road, Pudong New Area, Shanghai
上海浦东香格里拉大酒店
上海浦东新区，富城路 33 号

8:30	Welcome 欢迎仪式	Robert Rynning, Chair （Robert Rynning 主席） MN Barley Council 明尼苏达大麦委员会
9:00	6-row malting barley production 6 棱麦芽大麦生产	Marv Zutz, Exec. Director （Marv Zutz 执行董事） MN Barley Assoc. 明尼苏达大麦协会
9:30	Technical consideration of malting U.S. barley varieties/malting performances 关于美国麦芽大麦多样性的技术性考量和演示	Professor Paul Schwarz （Paul Schwarz 教授） Institute of Barley & Malt Sciences North Dakota State University 北达科他州州立大学，大麦及麦芽科学研究所
11:00	Industry malting of 6-row barley experience in the U.S. 美国工业制造 6 排麦芽大麦的经验	Alan Slater, Director（Alan Slater 董事） Midwest Barley Operations — USA Anheuser-Busch Companies 中西部大麦组织——美国 Anheuser Bush 公司
12:30	Lunch and open for questions 午餐及提问时间	

Each attendee will receive a 200 RMB transportation fee per company.
每家出席的公司将获得 200 元人民币交通费用

Please RSVP May or Cathy at SMH in Shanghai: 21-6888-9835, ext. 818.
请回复 May 或者 Cathy (上海晟明行)：021-6888-9835, 分机: 818.

US Six-Rowed Malting Barley Varieties: Technical Considerations

Dr Paul Schwarz

Director, Institute of Barley and Malt Sciences.

North Dakota State University

US Production Regions

- **West**
  - Idaho, Montana, Wyoming
  - Predominately 2-rowed barley
    - Small amounts (5%) of six-rowed in ID and MT.
  - Production under irrigation, and dryland
- **Upper Midwest**
  - North Dakota and Minnesota
  - 26% of USA total
  - Predominately 6-rowed barley
    - Increasing amounts (20%) of two-rowed in ND.
  - Almost all production is dryland
  - All spring barley

Breeding for Quality

- Only “recommended” varieties are used for malting
  - American Malting Barley Association
  - Performance is tested at multiple growing locations and over several years
  - Extensive “pilot- and plant-scale” testing before recommendation is given.
    - 10-12 year process

Breeding for Quality

- Breeding of six-rowed malting barley has a long history (>60 years) in the USA
  - Original six-rowed varieties (ca 1900) were from Northeast China (variety-Manchuria)
- Breeders
  - Busch Agricultural Resources
  - Miller-Coors
  - Universities (Minnesota, Montana, and North Dakota)
  - USDA

Major US Varieties 2010

- **Idaho**
  - 2-rowed
    - AC-Metcalfe
    - Conrad
- **Montana**
  - 2-rowed
    - AC-Metcalfe
    - Harrington
- **Minnesota - North Dakota**
  - **6-rowed**
    - **Tradition**
    - **Lacey**
  - 2-rowed
    - Conlon

Malting of US Varieties

- All US varieties can be germinated in 4 days (4 day malt)
  - Most European and Australian barley varieties require 5 days.
- Maltsters classify varieties by ease of modification
  - “Hot” modifies very quickly
  - “Normal” modifies well in 4 days at normal moisture.
  - “Slow” needs to be pushed to achieve good modification in 4 days
    - e.g. greater water requirement

Malting of US Six-Rowed Varieties

- Protein content and kernel size affect water uptake in steep
  - Thin kernels-faster
  - High protein-slower
- Distribution of kernel size can be greater with 6-rowed barley
  - Greater uniformity of modification can be achieved if six-rowed barley is graded (sized), and the grades malted separately

Malting of US Six-Rowed Varieties

- Malting Behavior
  - "Hot" rapid modification
    - Legacy
  - "Normal" modification
    - Stellar
    - Lacey
    - Tradition
  - "Slower" modification
    - Rasmusson (new variety: limited grain available)
    - Celebration (new variety: limited grain available)

Malting of US Six-Rowed Varieties

- Good modification and homogeneity can be achieved.
- However, there are differences in the malting of US Six-rowed when compared to European or Australian 2-rowed
  - Achieve uniform endosperm hydration
    - Higher steep-out moistures
  - Often need extensive protein modification (higher Kolbach index) to achieve extract yield and optimal fermentability.
  - Homogeneity can be improved by “sizing”

US Six-Rowed Barley Quality

Variety	1000 kernel weight (g)	Barley Protein (%)	Plump Kernels (%)	Extract (%)
Robust	32.6	13.7	78.2	78.7
Lacey	33.2	13.1	81.7	79.3
Tradition	33.0	13.2	88.2	79.0
Stellar-ND	33.3	13.3	85.3	79.3

- NDSU field trials.
  - Average of multiple years and locations.
- Pilot-malt data, USDA Cereal Crops Lab.
- Robust included for comparison (main variety for 20 years)

US Six-Rowed Barley Quality

Variety	1000 kernel weight (g)	Barley Protein (%)	Plump Kernels (%)	Extract (%)
Robust	32.6	13.7	78.2	78.7
Lacey	33.2	13.1	81.7	79.3
Tradition	33.0	13.2	88.2	79.0
Stellar-ND	33.3	13.3	85.3	79.3

- Protein
  - All new varieties are lower in protein than Robust
  - Newer variety Legacy is even lower
- Plumpness
  - Tradition and Stellar-ND have very high plumpness

US Six-Rowed Barley Quality

Variety	1000 kernel weight (g)	Barley Protein (%)	Plump Kernels (%)	Extract (%)
Robust	32.6	13.7	78.2	78.7
Lacey	33.2	13.1	81.7	79.3
Tradition	33.0	13.2	88.2	79.0
Stellar-ND	33.3	13.3	85.3	79.3

- Extract
  - Most varieties are comparable in extract.
    - average 79% extract (pilot-malt data)
  - New variety Rasmusson shows an increase.

US Six-Rowed Barley Quality

Variety	Wort Protein (%)	Kolbach Index (%)	Diastatic Power (WK)	Alpha-Amylase (DU)	Beta-Glucan (mg/liter)
Robust	5.51	41.5	597	64.7	155
Lacey	5.46	43.2	568	73.1	79
Tradition	5.08	40.0	688	78.6	81
Stellar-ND	5.65	44.1	674	82.5	48

- Most varieties have high soluble protein and extensive protein modification (Kolbach)
  - Tradition is lowest of current varieties

US Six-Rowed Barley Quality

Variety	Wort Protein (%)	Kolbach Index (%)	Diastatic Power (WK)	Alpha-Amylase (DU)	Beta-Glucan (mg/liter)
Robust	5.51	41.5	597	64.7	155
Lacey	5.46	43.2	568	73.1	79
Tradition	5.08	40.0	688	78.6	81
Stellar-ND	5.65	44.1	674	82.5	48

- **Enzymes**
  - Tradition and Stellar-ND have very high enzyme activity
- **Beta-Glucan**
  - All current varieties are <100 ppm
  - Should not pose a problem for adjunct brewers

Six-rowed Summary

- **Lacey**
  - Large acreage
  - Overall good quality
- **Tradition**
  - Large acreage: predominant six-rowed variety
  - Overall good quality
  - High DP
  - Some post-harvest dormancy issues

Six-rowed Summary

- **Legacy**
  - Limited acreage
  - A hot variety
    - High soluble protein, S/T and alpha-amylase
  - Lower protein, but also lower plump
  - Beta-glucans are above the average
  - It is prone to sprouting in the field, and farmers do not like this
  - Area sown to Legacy will likely decline

Six-rowed Summary

- **Stellar-ND**
  - Limited acreage at present
  - Overall good quality
  - High DP and alpha-amylase
  - Very low beta-glucan
  - Higher soluble protein
  - No dormancy issues
  - Acreage will likely increase in 2011

US Six-Rowed vs European 2-Rowed Barley

	Six-Rowed	Two-Rowed
Extract (%)	78.5-79.5	79-82
Soluble Protein (%)	5.5-6.0	<5.0
Kolbach Index (%)	42-47	35-41+
Free Amino Nitrogen (mg/L)	210-230	
Alpha-Amylase (DU)	45-60	
Diastatic Power (WK)	510-580	230-270

6-rowed vs 2-rowed Barley

- **Extract**
  - Generally an advantage with 2-rowed due to larger kernels and lower protein content
  - However, breeding efforts with 6-rowed barley have greatly reduced the differences and newer 6-rowed varieties are ≥80% extract
  - Significance? each 0.5 point increase in extract reduces malt requirement only by about 120 g/hL (<1% of total malt requirement).
    - Fermentability of extract is likely more important

6-rowed vs 2-rowed Barley

- **Protein**
  - Six-rowed barley is generally higher in total and soluble protein content
    - Both genetic and environmental factors
    - “low protein” genes have been incorporated into newer six-rowed varieties.
  - Six-rowed barley is almost always used in adjunct brewing
    - Adjuncts generally have no soluble protein.
    - Higher barley soluble protein and FAN levels are needed to support good fermentation

6-rowed vs 2-rowed Barley

- **Enzymes**
  - The true advantage of six-rowed barley is seen with levels of diastatic power (DP)
    - Almost double European 2-rowed
    - 20-30% higher than Canadian 2-rowed
  - High levels of DP allow use of greater levels of adjunct grains
    - Less malt is required in formulations using 6-rowed barley

A Word on Midwestern US Two-Rowed Barley

- The Midwestern USA now produces about 20% two-rowed barley

- Significant differences between Midwestern and Western two-rowed barley
  - Midwestern barley is dryland
  - Different germplasm used in development

Midwestern US Two-Rowed Barley Quality

Variety	1000 kernel weight (g)	Barley Protein (%)	Plump Kernels (%)	Extract (%)
Tradition (6)	33.0	13.2	88.2	79.0
Conlon (2)	42.2	13.0	94.4	79.8
Pinnacle (2)	43.6	11.9	95.0	80.8

- Colon was released in 1995
- Pinnacle was released in 2007
- Pinnacle offers significantly lower protein when compared to Conlon
- Acreage of Pinnacle is limited, but should increase in 2011

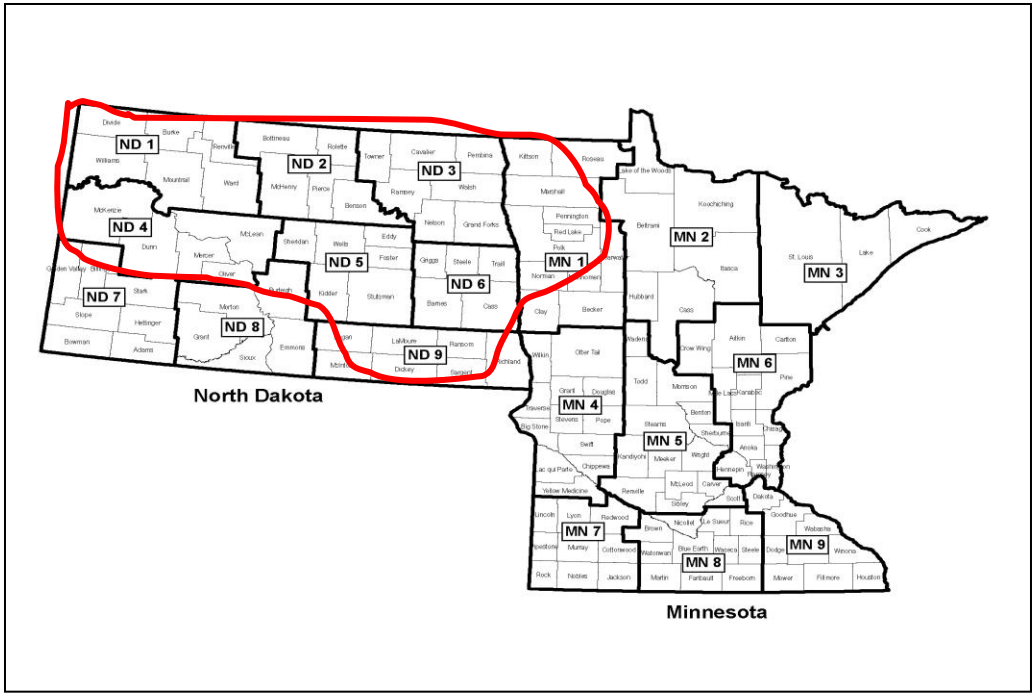
Midwestern US Two-Rowed Barley Quality

Variety	Wort Protein (%)	Kolbach Index (%)	Diastatic Power (WK)	Alpha-Amylase (DU)	Beta-Glucan (mg/liter)
Robust	5.51	41.5	597	64.7	155
Conlon	5.03	40.4	440	77.4	264
Pinnacle	4.92	42.7	380	70.4	175

- Pinnacle offers significantly lower protein and beta-glucans levels when compared to Conlon
- However, enzyme levels of both are lower than western 2-rowed or Midwestern 6-rowed

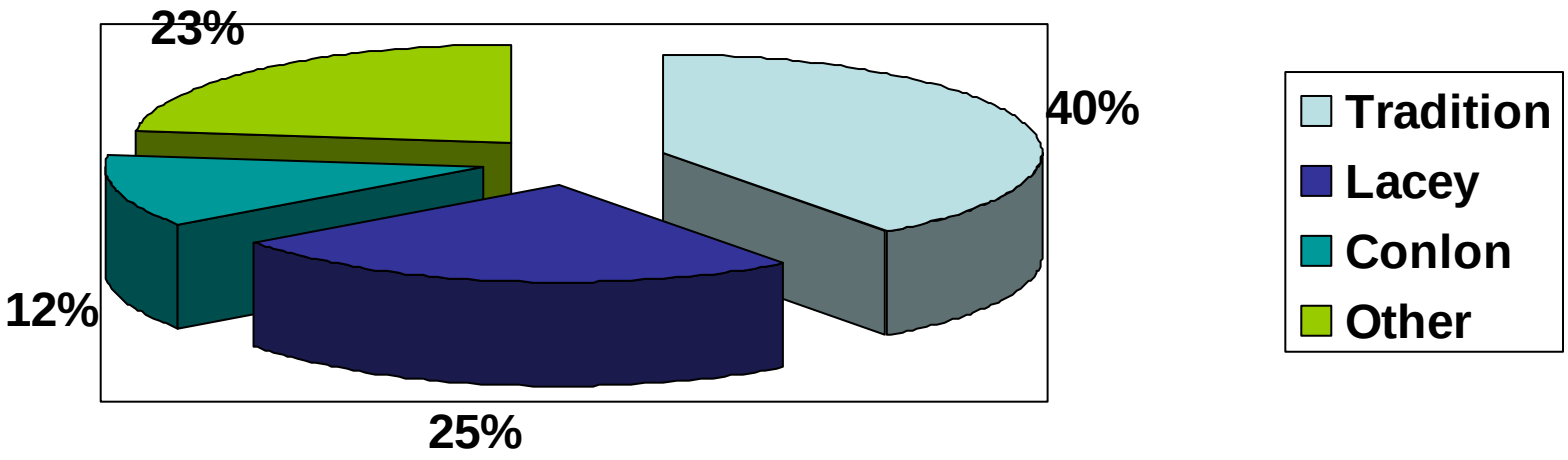
2010 Crop Quality:
North Dakota and Minnesota

Malting Barley Quality Survey



- 250 samples collected during harvest of 2010
- Analysis by North Dakota State University

2010 Midwestern USA
Barley Varieties Planted



2010 Crop Quality

- 1.05 million metric ton harvest estimate
  - (48.2 million bushels)

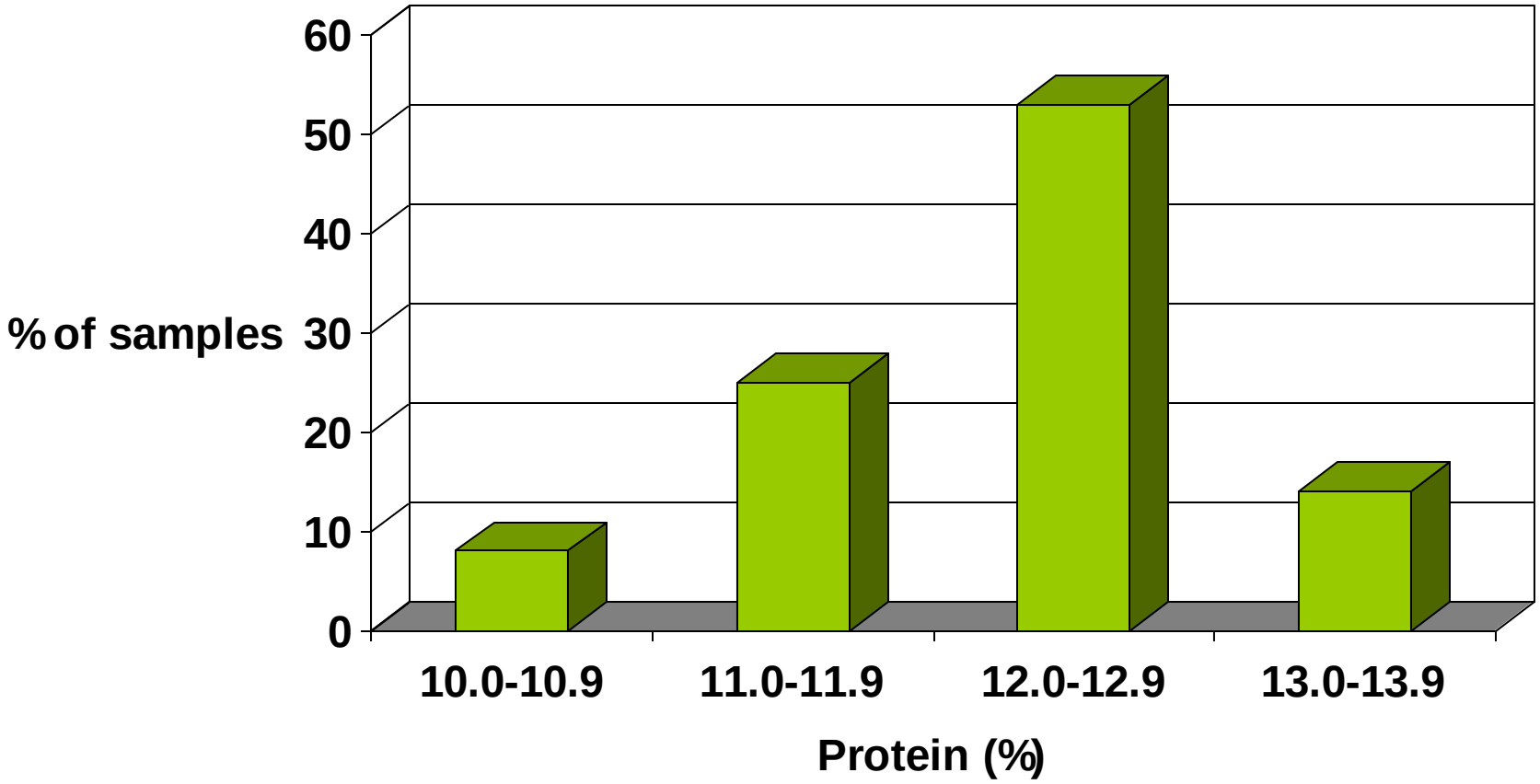
- Excellent crop quality
  - High kernel plumpness
  - Low to moderate protein
  - Absence of deleterious factors
    - Sprouting
    - Mycotoxins

- High percentage (>85%) of the crop should be selected as “malting quality”

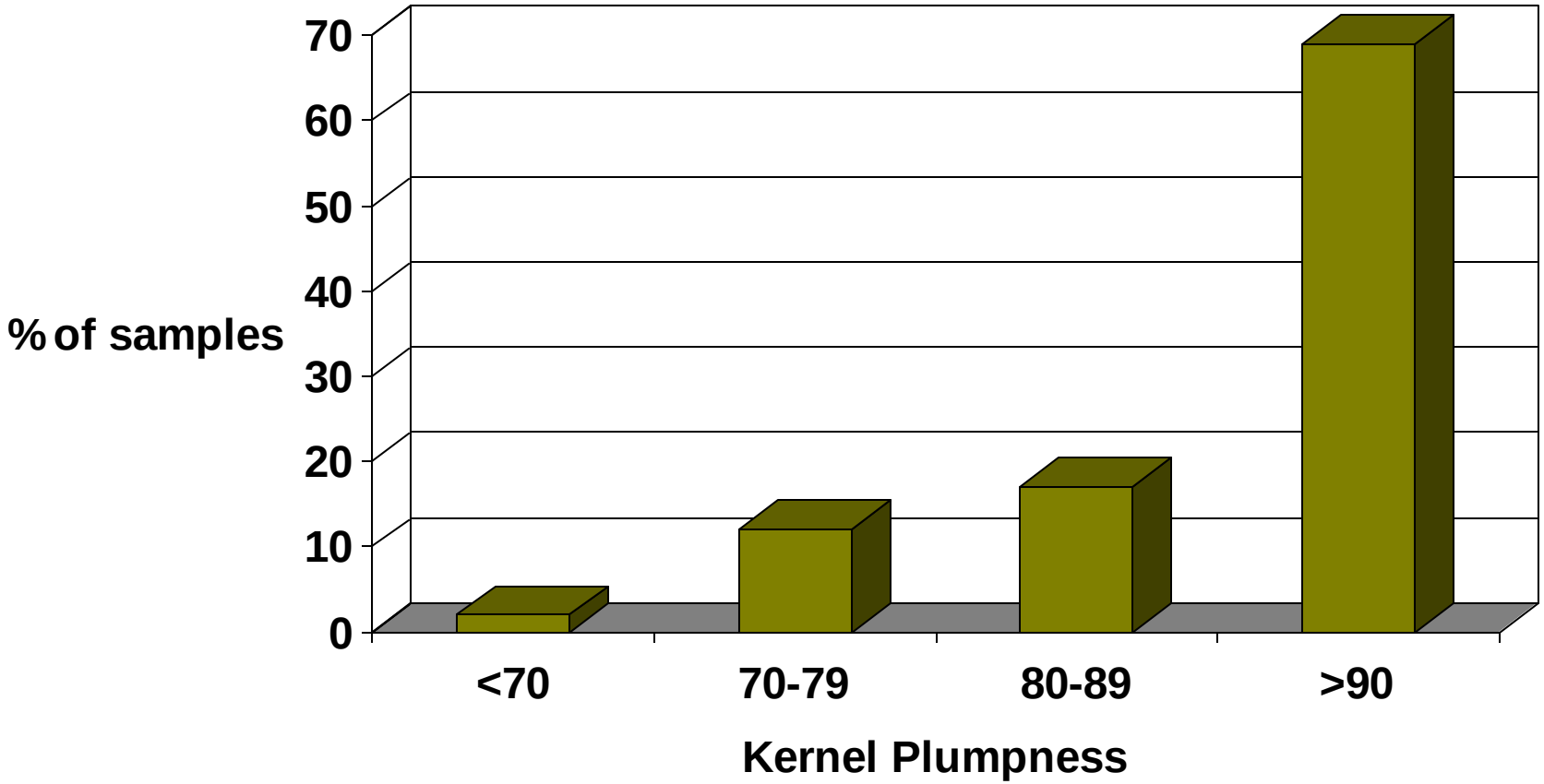
2010 Regional Quality

Variety	Row type	Protein (average %)	Plumpness (average %)	1000 kernel Weight (average %)
Tradition	6-row	12.3	90	38
Lacey	6-row	12.3	90	39
Stellar-ND	6-row	11.9	88	38
Conlon	2-row	12.2	88	46

Distribution of Protein in Tradition Barley (2010 Crop)



Distribution of Plumpness in Tradition Barley (2010 Crop)



Conclusions

- The USA has a long history of breeding and utilizing 6-rowed malting barley
- US farmers have more than 100 years experience in producing quality 6-rowed malting barley

Conclusions

- US 6-rowed malting barley is of high quality
- US 6-rowed barley is well suited for the production of light lager beers with cereal adjuncts
  - High DP and FAN allow the use of higher adjunct levels

Conclusions

- US 6-rowed malting barley offers an opportunity for diversification of supply.
- 2010 crop is of record quality
  - High selection rate (>85%) suggests that quality malting barley will be available for purcahse

6 Row Malting Barley Production in Minnesota and North Dakota

Marvin Zutz, Executive Director, Minnesota Barley

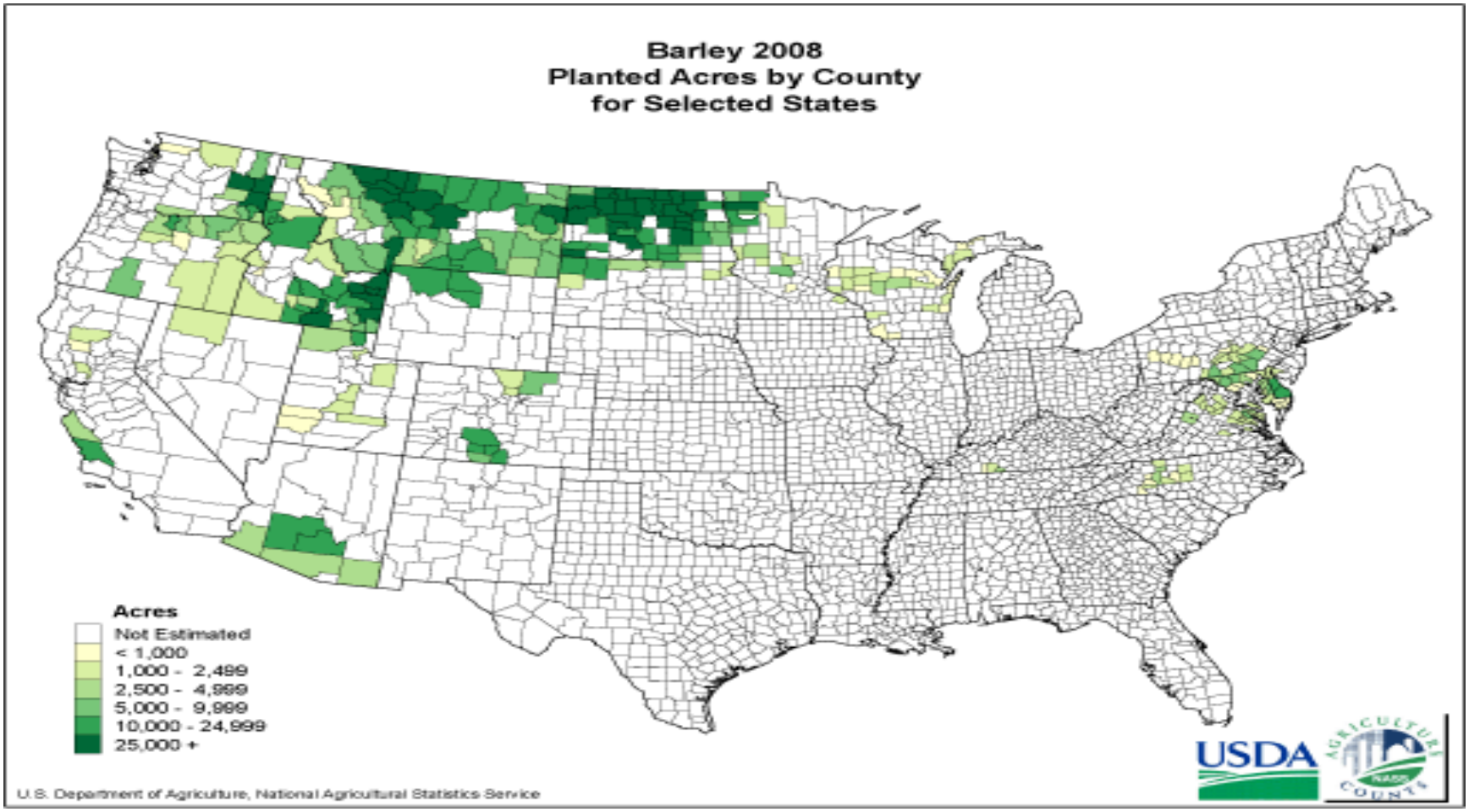
Jim Broten, Past Chair, U. S. Grains Council

Robert Rynning, Chair, Minnesota Barley Council

Objectives

- Review barley production regions.
- Review barley production trends.
- Review barley crop quality trends.
- Outline malting characteristics.
- Outline barley procurement strategies.
- Summary comments.

Barley Production Locations



Area Planted to Barley

Area Planted (Acres)

STATE	2006	2007	2008	2009
Minnesota	105,000	130,000	125,000	95,000
North Dakota	1,100,000	1,470,000	1,650,000	1,200,000

Area Planted (Hectares)

STATE	2006	2007	2008	2009
Minnesota	42,493	52,610	50,587	38,446
North Dakota	445,164	594,901	667,746	485,633

Area Harvested

Area Harvested (Acres)

STATE	2006	2007	2008	2009
Minnesota	90,000	110,000	110,000	80,000
North Dakota	995,000	1,390,000	1,540,000	1,140,000

Area Harvested (Hectares)

STATE	2006	2007	2008	2009
Minnesota	36,423	44,516	44,516	32,376
North Dakota	402,671	562,525	623,229	461,352

Barley Production in Minnesota and North Dakota

Production (Bushels)

STATE	2006	2007	2008	2009
Minnesota	5,400,000	5,940,000	7,150,000	4,960,000
North Dakota	48,755,000	77,840,000	86,240,000	79,800,000

Production (Metric Tons)

STATE	2006	2007	2008	2009
Minnesota	117,572	129,330	155,674	107,992
North Dakota	1,061,526	1,694,784	1,877,674	1,737,458

Barley Production By Variety

Variety	Type	Typical Use	Percent	Planted Area Acres	Planted Area Hectares	Harvested Area Acres	Harvested Area Hectares	Estimated Production Bushels	Estimated Production Metric Tons
Tradition	6 row	Malting	46.00%	556,600	225,253	524,400	212,222	36,708,000	799,231
Lacey	6 row	Malting	16.40%	198,440	80,308	186,960	75,662	13,087,200	284,943
Stellar-ND	6 row	Malting	4.00%	48,400	19,587	45,600	18,454	3,192,000	69,498
Conlon	2 row	Malting	17.70%	214,170	86,673	201,780	81,659	14,124,600	307,530
Legacy	6 row	Malting	2.00%	24,200	9,794	22,800	9,227	1,596,000	34,749
Robust	6 row	Malting	3.40%	41,140	16,649	38,760	15,686	2,713,200	59,074
Rasmusson	6 row	Malting	0.70%	8,470	3,428	7,980	3,229	558,600	12,162
Haybet	2 row	Feed	2.90%	35,090	14,201	33,060	13,379	2,314,200	50,386
Logan	2 row	Feed	0.30%	3,630	1,469	3,420	1,384	239,400	5,212
Pinnacle	2 row	Malting	0.70%	8,470	3,428	7,980	3,229	558,600	12,162
Bowman	2 row	Feed	0.20%	2,420	979	2,280	923	159,600	3,475
Stark	2 row	Feed	0.30%	3,630	1,469	3,420	1,384	239,400	5,212
Conrad	2 row	Malting	0.30%	3,630	1,469	3,420	1,384	239,400	5,212
Hays	2 row	Feed	0.20%	2,420	979	2,280	923	159,600	3,475
Other	NA	NA	7.10%	85,910	34,767	80,940	32,756	5,665,800	123,360
TOTALS:			100.00%	1,236,620	500,453	1,165,080	471,501	81,555,600	1,775,682

6 Row Barley Crop Quality Trends

ITEM	2009	2008	2007	2006	2005	2004	2004 to 2009 5 Year Avg.
Number of samples analysed	185	214	229	217	225	239	218.2
Test weight (pounds per bushel)	48.5	47.0	46.6	46.7	45.9	47.5	47.0
Test weight (kg/hl)	62.4	60.0	60.0	60.1	57.4	61.1	60.2
1000 kernel weight (grams)	40.3	36.1	35.8	31.9	34.3	35.8	35.7
Protein (%)	11.8%	12.7%	12.5%	12.9%	12.8%	12.7%	12.6%
Moisture (%)	13.6%	12.7%	12.3%	12.0%	12.7%	14.0%	12.9%
Damaged Kernels (%)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Sound Barley (%)	100.0%	99.9%	100.0%	99.9%	99.9%	99.8%	99.9%
Thin Barley (%)	0.9%	2.9%	3.8%	8.1%	3.6%	2.8%	3.7%
Broken Kernels (%)	1.3%	1.4%	2.0%	1.5%	2.1%	2.5%	1.8%
Plump Kernels (%)	91.4%	75.5%	74.5%	57.3%	74.7%	79.6%	75.5%
Grades							
--U. S. Number 1	99.90%	99.90%	NA	99.90%	NA	99.90%	NA
--U. S. Number 2	NA	NA	99.90%	NA	99.90%	NA	95.00%
--U. S. Number 3	NA	NA	NA	NA	NA	NA	NA
--U. S. Number 4	NA	NA	NA	NA	NA	NA	NA
--U. S. Number 5	NA	NA	NA	NA	NA	NA	NA
--U. S. Sample Grade	NA	NA	NA	NA	NA	NA	NA

Malting Barley Quality Considerations

- Primary quality parameters for Minnesota and North Dakota 6 row barley.
  - Protein (%).
    - Typical range: 11% to 13%.
  - Plump.
    - Measurement (in percent) of seed size.
      - Barley kernels retained on or above a 2.4 x 19 mm slotted sieve.
    - Typical range: 75% - 90%.
  - Malting time.
    - Typically can be malted in 4 days (1 day earlier than European or Australian varieties).
      - Allows for greater efficiency in the malting factory.
  - Enzyme profile enhances malting and brewing process.

Quality Considerations for Malted Barley

- Extract.
- Friability.
  - A measurement of the readiness of the malt to crumble when subjected to crushing.
    - Should be greater than 85% friable.
- Diastatic Power (DP).
  - Malted 6 row barley from Minnesota and North Dakota typically has higher DP than European or Australian varieties.

Quality and the Barley Farmer

- The farmer's decision to produce malting barley is based on economics
  - Yield, price, and production costs are factors.
  - Barley must meet quality specifications to receive premium price
  - Thus, the farmer is only interested in quality parameters for which their barley is tested (example: protein)

Malting Barley Procurement Strategies

- Malting barley is becoming a specialty crop.
  - Influenced by quality standards required in malting and brewing.
- Malting Barley is increasingly procured (purchased) under contract production agreements with growers.
- Contract components include but are not limited to quantity, price, variety, quality parameters, delivery period, and management practices.

Summary

- Minnesota and North Dakota continue to produce high quality 6 row malting barley.
- Malting barley production is becoming more specialized, and procurement is conducted under contract arrangements.
- Minnesota and North Dakota look forward to supplying 6 row malting barley to China for malting and brewing.

Summary

- Minnesota and North Dakota relationship with China.
  - Provide technical support regarding use of 6 row malt barley in malting and brewing.
  - Provide information on crop contracting.
  - Provide information on barley supply and market conditions.
  - Provide contacts to assist in procuring, shipping, and delivering 6 row barley to China from North Dakota and Minnesota.

Barley Acquisition Programs

Presented by Alan J. Slater

Barley in the United States

- Introduced to this hemisphere by Columbus in 1492
- European settlers brought the barleys of their homelands to the US
- Concentrated in New York State during the mid 1800s
- Concentrated in Wisconsin and the Red River Valley of North Dakota and Minnesota during the early 1900s
- Expanded to the Inter Mountain West when hybrid corn was introduced to the Midwest in the 1930s

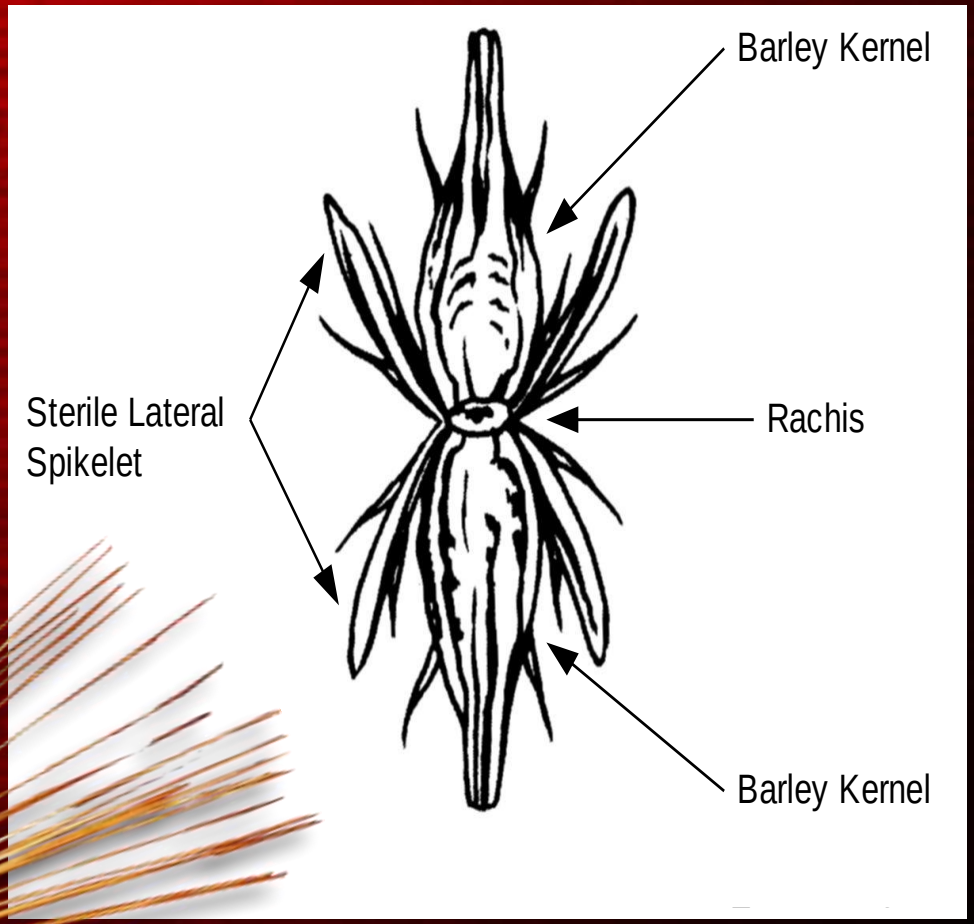
Two Row and Six Row Basics

- Same taxonomy – Hordeum *vulgare*
- Both have existed since pre history
- Six row dominated in the US into the 1940's
- Both make excellent malt and beer

USA uses both six row and two row barley malts in blends to make its portfolio of beers

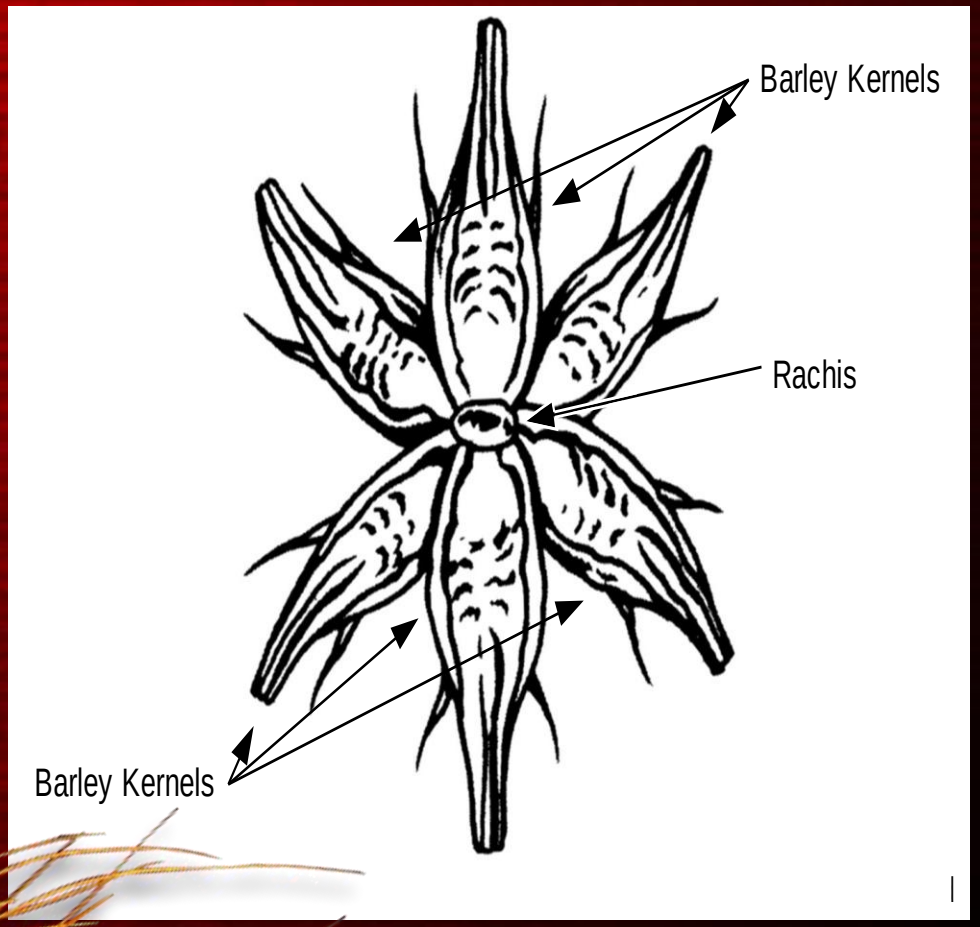
Two Rowed Barley

- Two rowed barley has one fertile spikelet per rachis node. It appears to have two rows of kernels when viewed from the top of the spike
- Kernel size and shape are very uniform
- Provides a smooth, mellow sweetness to beer



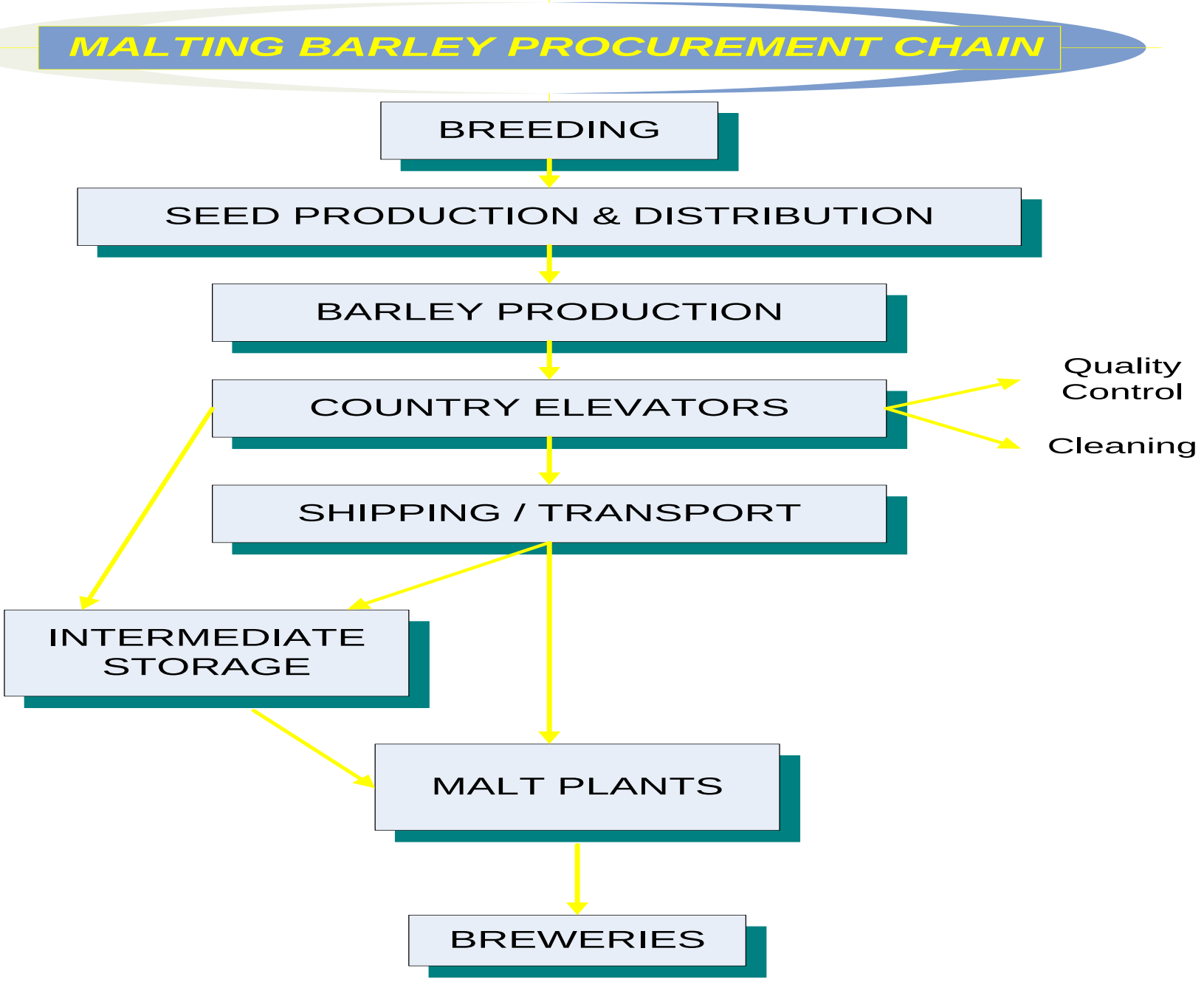
Six Rowed Barley

- Six rowed barley has three fertile spikelets per rachis node. It appears to have six rows of kernels when viewed from the top of the spike
- Lateral kernels are smaller and twisted
- Imparts crispness and snap to beer

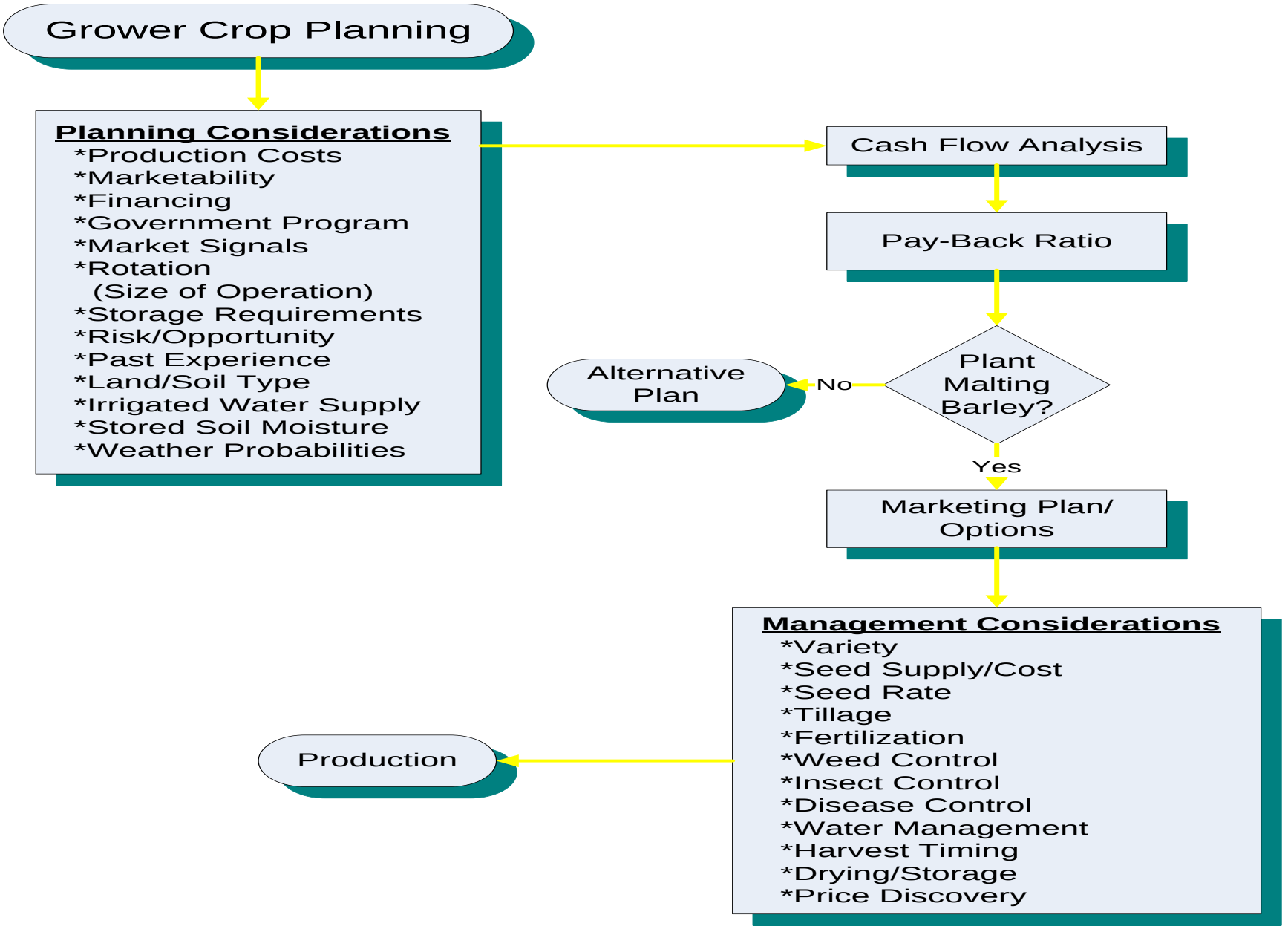


Commitment To The Total Barley Supply Chain

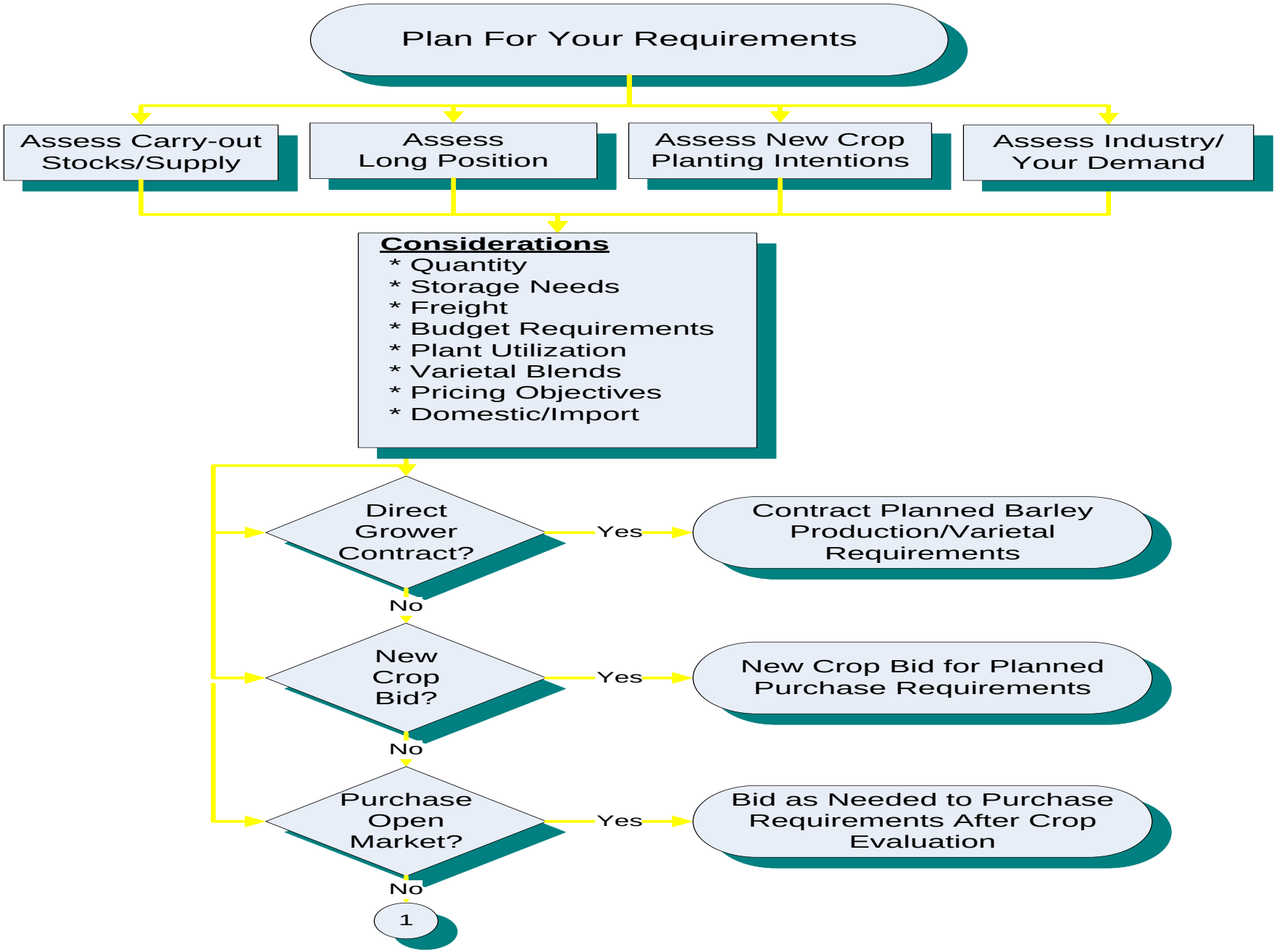
- Barley breeding and new variety development
- Certified seed production and distribution
- Field representatives consulting with farmers from planting through harvest
- Barley receiving elevators throughout the production area to gather barley
- Certified barley graders closely inspecting every truckload of barley entering the system


MALTING BARLEY PROCUREMENT CHAIN
BREEDING
SEED PRODUCTION & DISTRIBUTION
BARLEY PRODUCTION
COUNTRY ELEVATORS
Quality Control
Cleaning
SHIPPING / TRANSPORT
INTERMEDIATE STORAGE
MALT PLANTS
BREWERIES

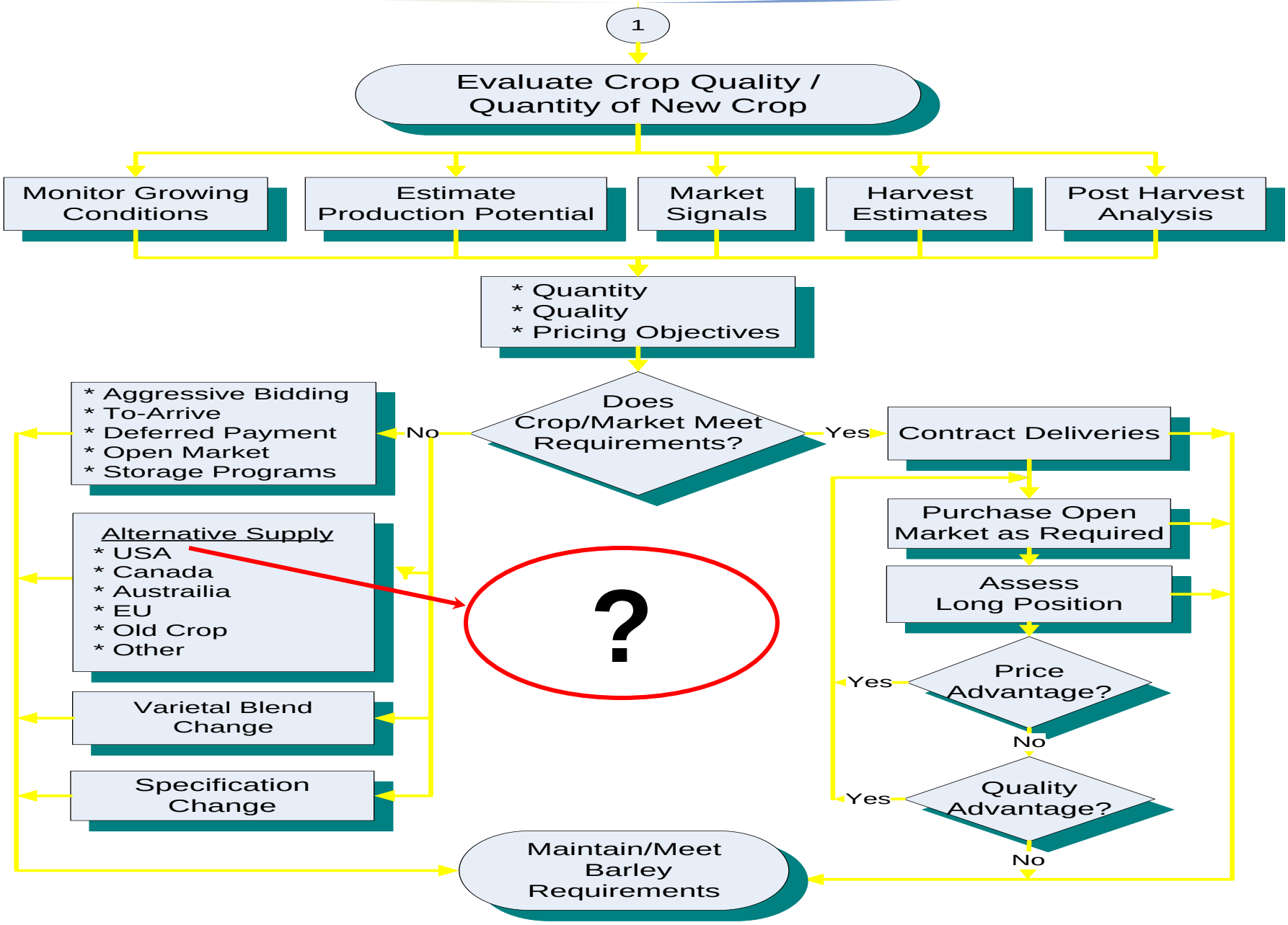
Grower Decision Process



Supply Chain Planning



Supply Chain Planning



What is the ultimate goal?

Where do you need to be, and how do you get there?

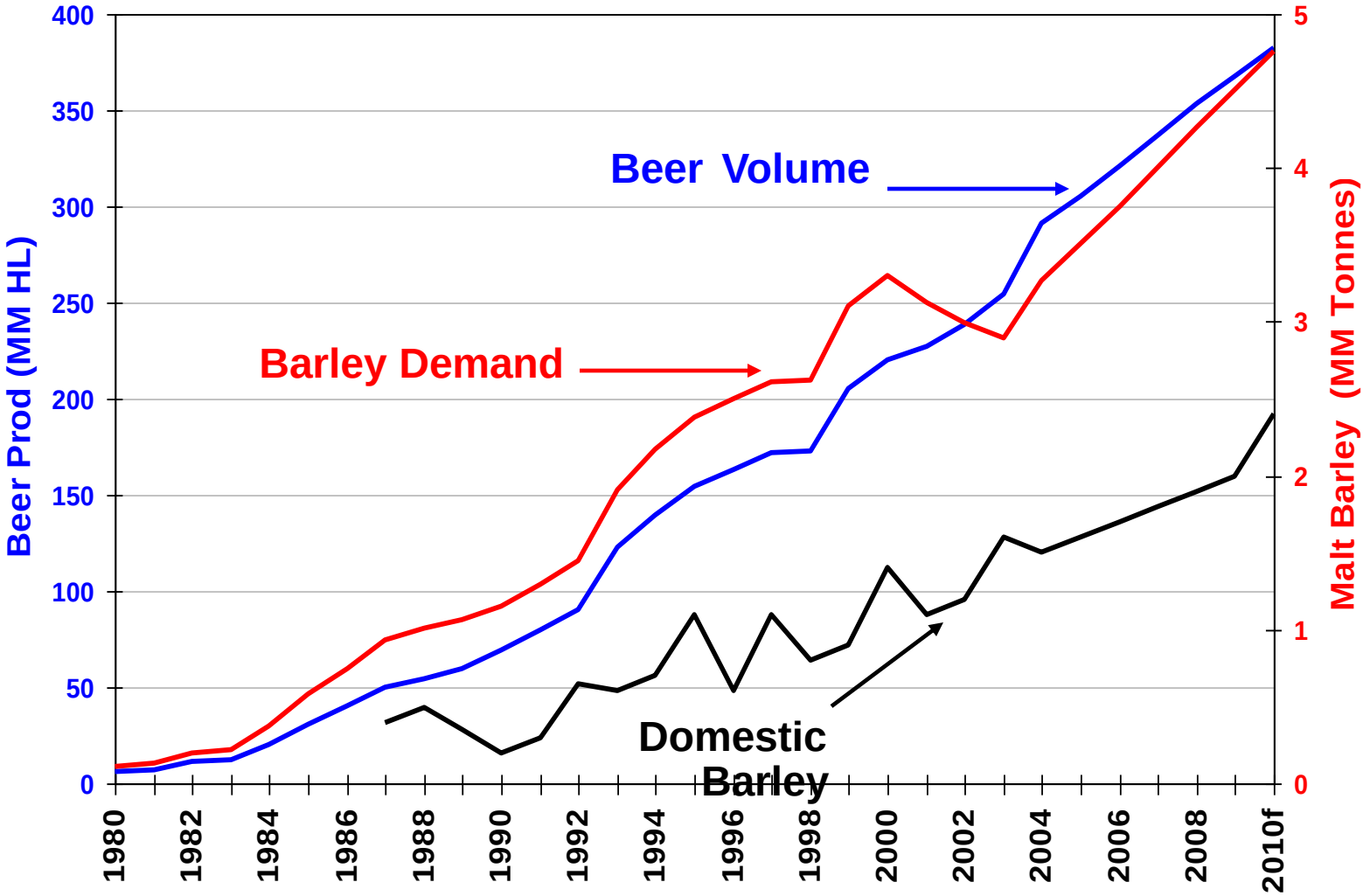
<u>Are you prepared for future impacts?</u>

- **Impact of Climate**
- **Food Consumption Growth-Drives Competing Crops**
- **Growing Demand of Developing Economies**
- **Other?**

Goal of Your Supply Chain

Goal: A stable, flexible and reliable world supply of quality malting barley

Current Situation
Growth in Beer Production vs. Barley Demand



Domestic barley supply gap is not meeting growth

Current Situation
Barley Supply and Demand

- China barley demand is ~3.5MM metric tons

  Supply

  - Domestic: Continue to promote- Very important!
  - Imported:
    - » Australia
    - » Canada
    - » Europe
    - » USA ?

Malt imports limited due to tariff structure favoring barley

Current Situation

- Options to meet production demands if you do nothing
  - Escalate barley imports and
  - Use more adjuncts

Ensuring Availability

- Contracting Methods
- New Area Development-Expand
- Diverse Growing Regions
- Communicate with Growers
- Prioritize projects that:
  - Increase Malting Acceptance
  - Stimulate Barley Acreage
  - Reduce Variability
  - Quality Data

Multiple Origin Alternatives

Why add USA?

- Geographic diversity – supply security
- Commercial diversity - cost leverage
- Agronomic diversity - capture potential regional attributes
- Discovery
  - Technological Developments
  - Logistics
  - Other
- Sustain Barley Growers/Production
- Technical Support

Reliable Supplier System

Why USA:

- Contract Security
- Supplier Quality Systems/Varieties
- Market Intelligence

Predictable

Why:

- Ability to Forecast
- Purchasing Options
- Superior Storage for Accumulation

Flexible Purchasing Structure

Why:

- Supply security
- Price averaging

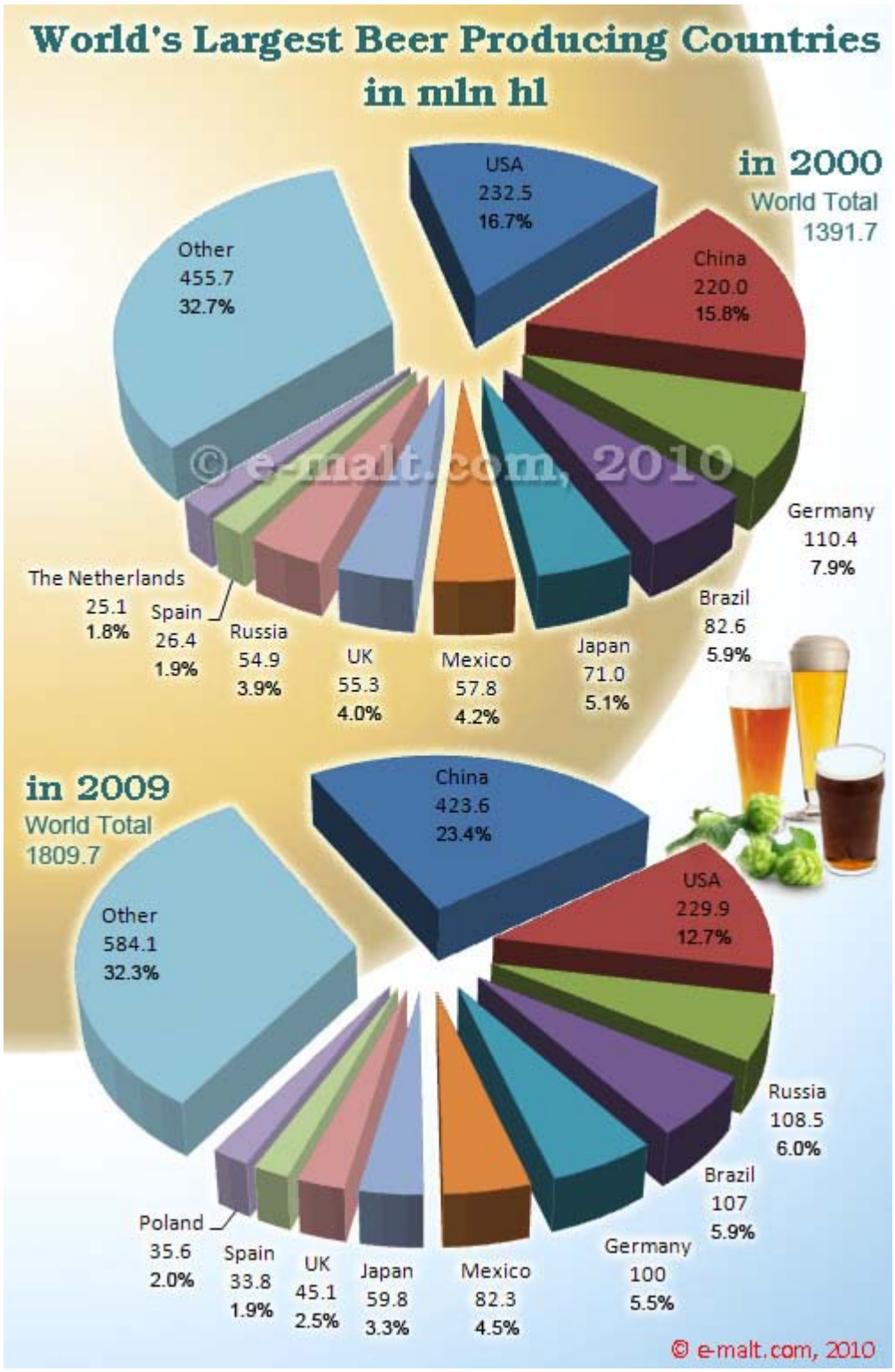
Obstacles

What is holding us back?

Now what?

So how *DO* we Work Together?


Thank-you


World's Largest Beer Producing Countries
in mln hl
in 2000
World Total
1391.7
USA
232.5
16.7%
China
220.0
15.8%
Germany
110.4
7.9%
Brazil
82.6
5.9%
Japan
71.0
5.1%
Mexico
57.8
4.2%
UK
55.3
4.0%
Russia
54.9
3.9%
Spain
26.4
1.9%
The Netherlands
25.1
1.8%
Other
455.7
32.7%
© e-malt.com, 2010
in 2009
World Total
1809.7
China
423.6
23.4%
USA
229.9
12.7%
Russia
108.5
6.0%
Brazil
107
5.9%
Germany
100
5.5%
Mexico
82.3
4.5%
Japan
59.8
3.3%
UK
45.1
2.5%
Spain
33.8
1.9%
Poland
35.6
2.0%
Other
584.1
32.3%
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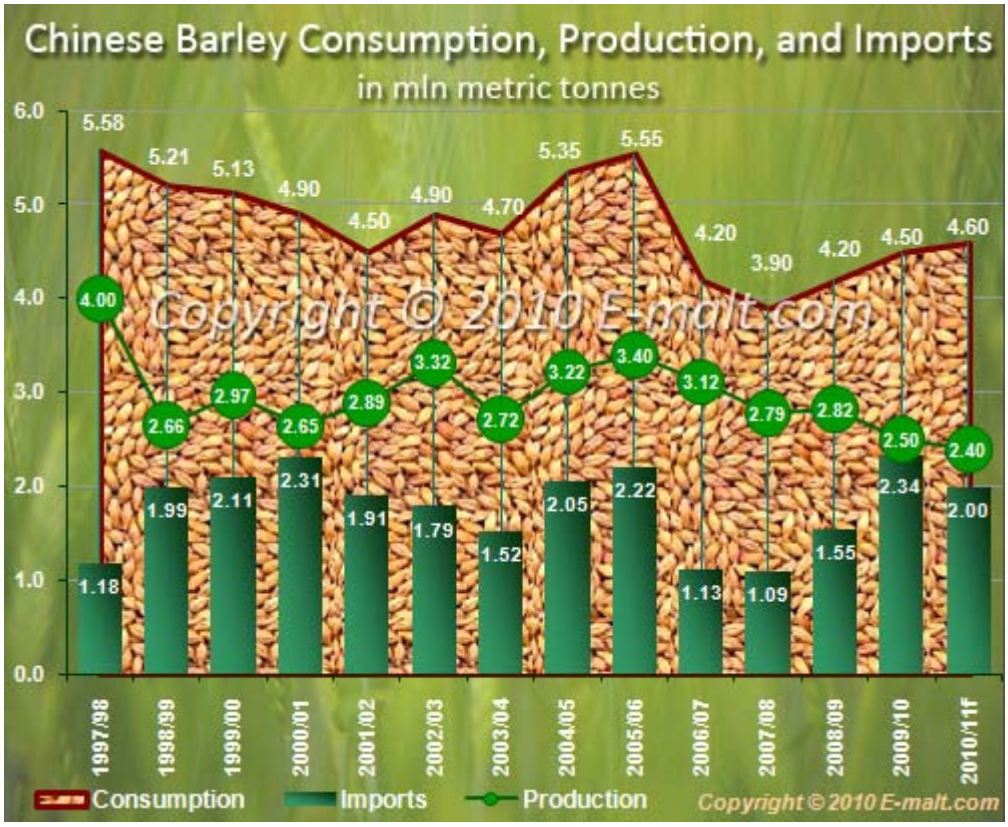
Chinese Barley Consumption, Production, and Imports
in mln metric tonnes
6.0
5.0
4.0
3.0
2.0
1.0
0.0
5.58
5.21
5.13
4.90
4.50
4.90
4.70
5.35
5.55
4.20
3.90
4.20
4.50
4.60
4.00
2.66
2.97
2.65
2.89
3.32
2.72
3.22
3.40
3.12
2.79
2.82
2.50
2.40
1.18
1.99
2.11
2.31
1.91
1.79
1.52
2.05
2.22
1.13
1.09
1.55
2.34
2.00
1997/98
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2000/01
2001/02
2002/03
2003/04
2004/05
2005/06
2006/07
2007/08
2008/09
2009/10
2010/11F
Consumption
Imports
Production
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