

# Working Together - A Japanese Brewing Company's Barley Breeding Strategy

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## Abstract

More than 15% of malt used by Japanese brewing companies is imported from Australia. However, varieties such as Schooner are no longer popular with our brewers because of their lower extract, diastatic power and fermentability compared with other leading varieties, such as Alexis and Harrington. We have observed the recent advancements that have occurred in the Australian barley breeding programs in terms of increased co-ordination and streamlined quality testing. As a customer, we asked what could Sapporo Breweries do to further assist the stable supply of quality malting barley in Australia.

Sapporo's management philosophy places great importance on barley and hops for beer and so barley breeding has been a time-honored tradition. By developing partnerships with Australian barley breeding programs through the exchange of up-to-date information and breeding materials we believed it would be mutually beneficial to both Sapporo and the Australian industry. Thus we commenced a collaborative breeding program in Australia, which has progressed thanks to our partner in the program, the University of Adelaide and valuable advice of the maltsters. The object and progress of the program will be summarised in this paper.

## Introduction

### *Australia as an important supplier*

Beer production in Japan is 7,178,900kl (1997), which is the world's fifth biggest, following U.S.A., China, Germany and Brazil. Out of 801,000t of malt used for this purpose, more than 95% (763,000t) is imported. The main areas exporting malt to Japan are Australia, Canada and Europe (Fig. 1), where Australia contributes 15.5% of the malt imports to Japan. Sapporo Breweries Ltd., one of the major brewing companies in Japan, therefore depends on a considerable amount of Australian malt. Therefore, stable supply of quality barley and malt from Australia is our great interest and concern.

However, varieties such as Schooner are no longer popular with our brewers because of their lower extract, diastatic power and fermentability compared with other leading varieties, such as Alexis and Harrington. The main reason why they prefer malt with high diastatic power may be attributed to the ingredients used in brewing. Besides malt and hops, starch adjuncts are usually used for our standard beer products such as Sapporo Black Label, where malt usage is approximately 67% of the ingredients. High diastatic power is necessary to ensure complete degradation of these starchy substances.

We therefore needed to make an action to assist the stable supply of quality malting barley in Australia, which should be originated from Sapporo's tradition and management philosophy.

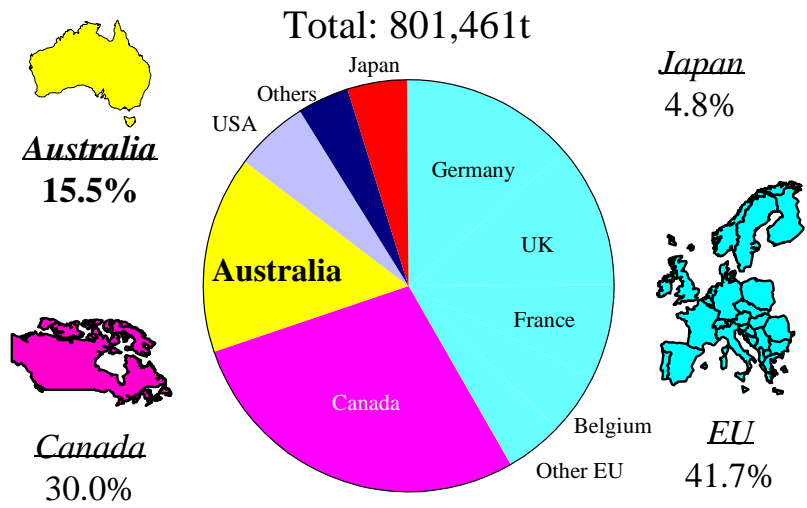


Fig. 1. Origins of the malt used by Japanese brewing companies (1997).

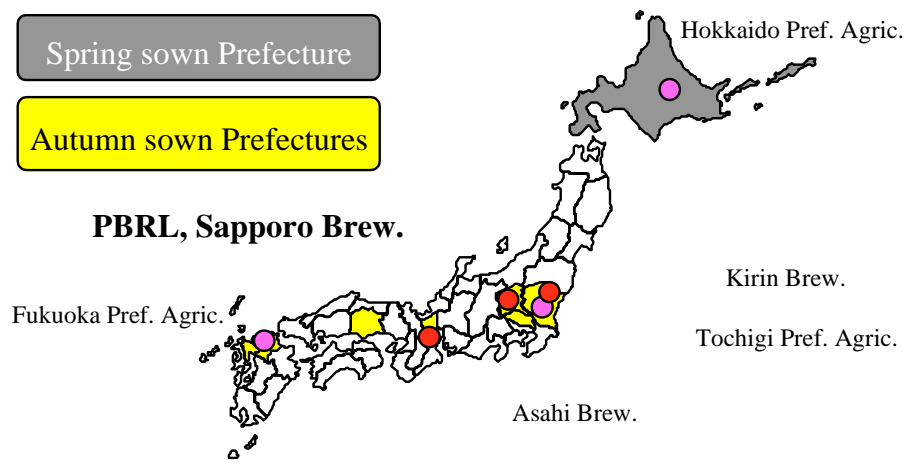
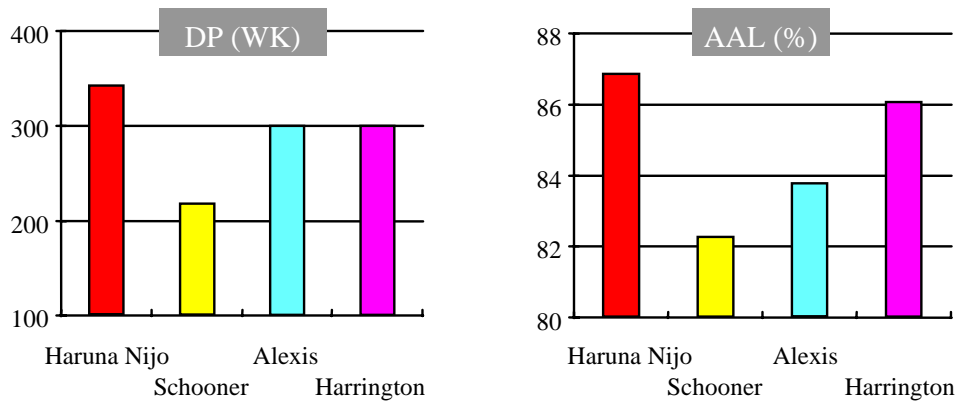
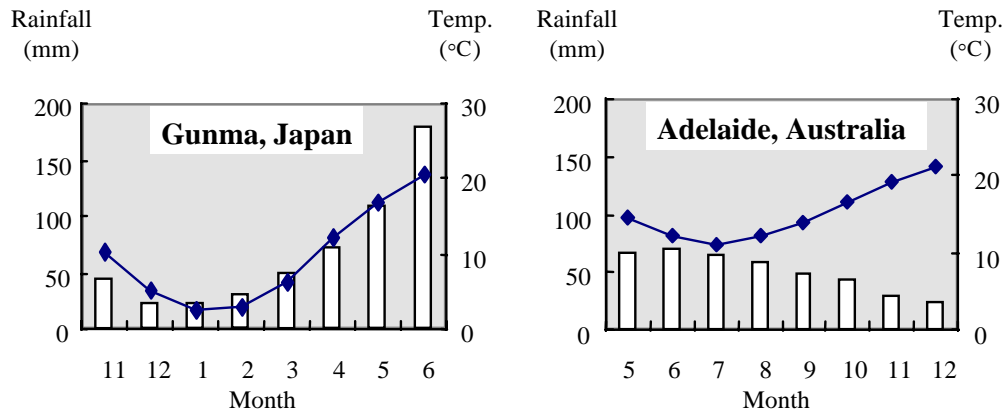


Fig. 2. Major malting barley growing areas and breeding stations in Japan.

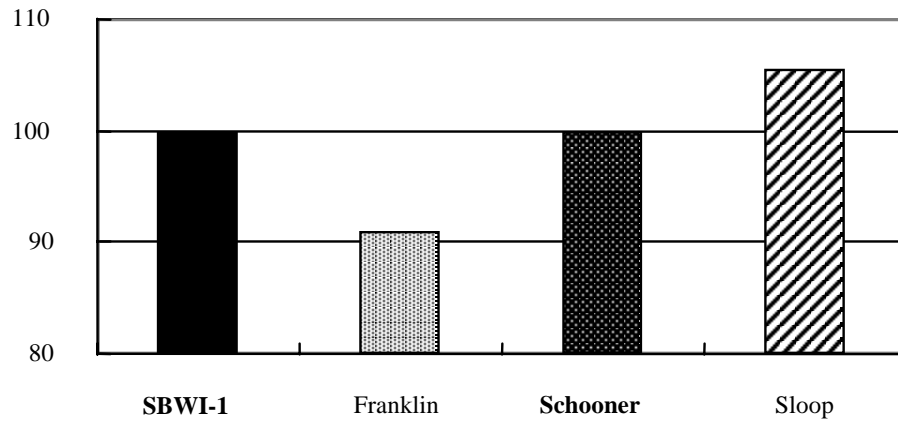


**Fig. 3.** Comparison of malting quality of the leading varieties.

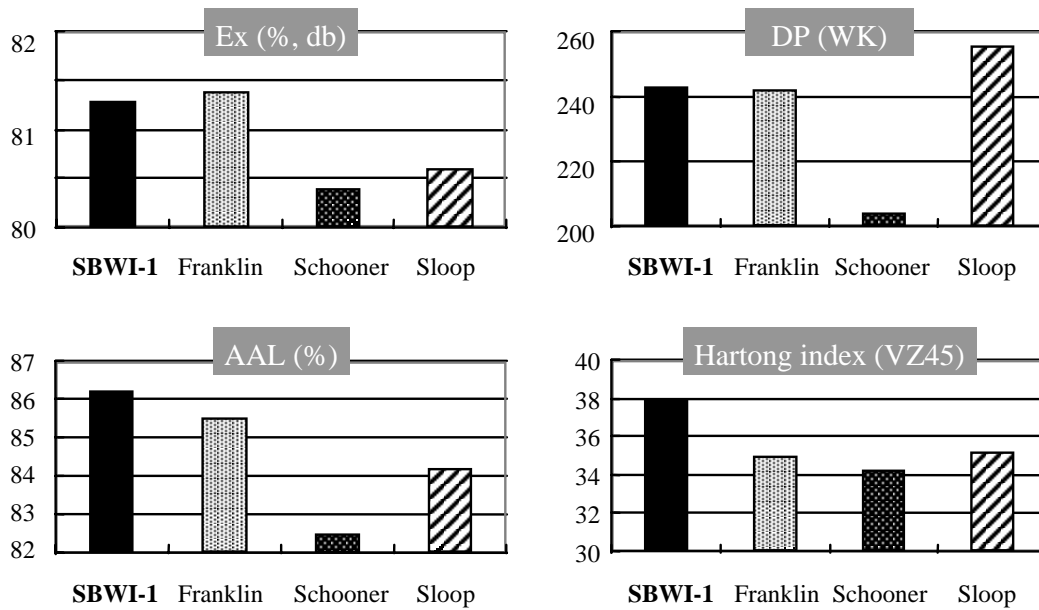


**Fig. 4.** Climate of Japan (Gunma) and South Australia (Adelaide).

◆ : Temperature (°C)  
 □ : Rainfall (mm)



**Fig. 5.** Grain yield of SBWI-1 (Mean of 1998 crop; as % of Schooner).



**Fig. 6.** Malt quality profile of SBWI-1 (Mean of 1997 & 1998 crops).

### *Barley Breeding: Proud Tradition*

Under the polar star in 1876, the very first brew of Sapporo Beer was brewed in the north city of Japan, Sapporo, Hokkaido. In the next year, the predecessor of the present Sapporo Breweries introduced nine varieties of two rowed barley from overseas and tested them in Hokkaido. Since its establishment, Sapporo's management philosophy places great importance on barley and hops for beer and so barley breeding has been a time-honored tradition. The Plant Bioengineering Research Laboratories is now responsible for the company's barley breeding.

We have led malting barley breeding in Japan and released various leading varieties, in cooperation with public breeding stations and the other brewing companies (Fig. 2). Haruna Nijo, for example, is one of the major outcome of our breeding activities (Table 1). This excellent variety was released in 1978 and enjoys the reputation as one of the highest malting and brewing quality varieties in Japan. Various breeding programs are still using it as a high quality parent in their crossing. Our varieties are characterised by high diastatic power and fermentability, which reflects our brewers' quality requirements (Fig. 3). That is to say, they are best suited for Japanese brewing.

**Table 1.** Quality profile of the recently released varieties bred by Sapporo Breweries.

| Variety     | Year of Registration | Extract (% db) | Kolbach Index | Diastatic Power (WK) | Apparent Attenuation Limit (%) |
|-------------|----------------------|----------------|---------------|----------------------|--------------------------------|
| Haruna Nijo | 1981                 | 83.7           | 48.9          | 332                  | 84.7                           |
| Tone Nijo   | 1989                 | 81.5           | 40.6          | 287                  | 84.2                           |
| Myogi Nijo  | 1991                 | 84.2           | 49.1          | 301                  | 86.0                           |

To breed barley with enhanced quality characters, we acknowledge the need for cooperation. 'Working Together' is, in this sense, our proud tradition.

### *Challenging Strategy*

In recent years malt imports to Japan have steadily increased while domestic malting barley rapidly lost its share mainly because of the price advantage of the imported malt. Most of the Japanese brewing companies seem to have reduced their domestic barley breeding programs as a consequence. However, Sapporo has continued its breeding work and adopted another challenging strategy. We planned to extend our breeding expertise and germplasm to overseas, aiming to create varieties in the major malt supplying areas which meet our brewing demands. What we intended was to secure stable supply of quality barley and malt from all over the world. One of the new fields for our breeding activity was set in Australia.

We assumed it would be beneficial for both Sapporo and the Australian barley and malting industries if we could develop a new malting barley variety which meets our brewing demands. Since 1992 we have developed partnerships with the Department of Science, the University of Adelaide through exchanging up-to-date information and breeding materials. In the course of the provisional period, we have also observed the recent advancements that have occurred in the Australian barley breeding programs in terms of increased co-ordination and streamlined quality testing. By combining our germplasm in conjunction with the refined breeding and quality assessment program in Australia, we aimed to create a new variety.

Thus we commenced a collaborative breeding program in Australia with the University of Adelaide in 1996. The program has progressed thanks to our partner, and valuable advice of

the Australian maltsters. In the next section we will briefly describe the advancement of the program so far.

## **Sapporo's Australia Program**

### *Outline*

The main scheme of the program is constituted of the following two streams; one is sending Sapporo's breeding lines to South Australia and selecting the best ones, and the other is sending cross seeds to develop a new line in SA.

Field trials are conducted and organised by the University of Adelaide in their breeding sites. The University also undertakes quality evaluation of the early generation material while the advanced lines are fully analysed in Sapporo's quality laboratory according to its standard protocols. Sapporo financially supports the program and sends staff to South Australia for field evaluation and selection.

### *Hurdles*

Except for Hokkaido, we grow barley during winter, which is the same as the case in South Australia (Fig. 4). Based on the climatic similarity, we firstly anticipated our breeding lines would be easily adapted to the South Australian environment and sent them to be tested. However, the harsh climate of this country produced some unexpected challenges. The most severe problem was shattering. Two factors were assumed to cause it selectively on our lines.

The first one was thought to be the difference in maturity. In our climate, malting barley is harvested in early summer; late May through early June, when the rainy season begins. Since rain in harvest time causes quality problem on the crop including gushing by *Fusarium*, intense breeding efforts have been made for shortening the maturity period. As a result, Japanese breeders have developed varieties ripening much earlier than Australian ones. The earlier the maturity is, the more fragile the spikes and culms are in dry the harvest time in South Australia leading to shattering.

The second factor was regarding plant type. In order to avoid spikes getting mouldy by being surrounded by a flag leaf sheath under our humid conditions, the breeders selected barley with a long peduncle. This trait enhances the risk of losing spikes by increasing their moment caused by strong wind. Therefore, Japanese lines tend to be more susceptible to shattering.

We selected lines similar to those of South Australia in terms of maturity and plant type. The selected lines showed improved resistance to shattering. Out of more than 600 lines which we have sent to South Australia and through several years of field trials and quality testing, we have some promising lines, one of which is being evaluated in stage 4 trials (SBWI-1, Sapporo Breweries & Waite Institute collaborative line No. 1).

### *Progress*

SBWI-1 yields over 90% of Schooner if not equal to in statewide average (Fig. 5). This is a significant advance from the first batch of our breeding lines, which yielded 60-70% of Schooner. The quality profile of the line is good; with reasonably high extract and DP, and high fermentability and Hartong index (VZ45) (Fig. 6). We have begun pure seed production of SBWI-1 and are going to assess its brewing quality by pilot-scale brewing later this year. We hope to obtain PBR in the next year.

The progress of the program largely depends on fine organization of field trials and quality evaluation made by the University of Adelaide. Valuable advice and support from Australian maltsters has also made a great contribution. Such harmonious relationships between Japanese and Australian partners have enhanced the program's success.

SBWI-1 is expected to contribute to stable supply of malting barley in Australia which meets our brewing requirements. Although the progress may not be a big advantage in Australia in economic terms, we are sure that we have built a steady and active pipeline between Sapporo and Australia, which may be another outcome of our breeding program in Australia.

Through the pipeline, information on the Japanese malt market's requirements comes from Sapporo to Australia, while new varieties which meet our brewing demands come from Australia to Sapporo as malt. The new varieties are not necessarily bred by us. The aim of the program is to secure stable supply of quality barley in Australia. What is most important is that the quality profiles of the varieties meet our requirements. We believe maintaining the pipeline active is beneficial to both Sapporo and Australia and we would like to continue this collaborative breeding work.

### **Towards The Future**

It is hard to predict the best selling beer in the near future. Sparkling beer (Happoshu), for example, has recently obtained a greater share of the Japanese brewing product market but few people could have expected this trend ten years ago. Breeders are required to release varieties which meet the present demands of the brewers but the crossing has usually been done more than ten years before you can actually see the *present* market. That means we have to anticipate the future market trends when we develop our present breeding strategy.

One of the practical solutions for this difficulty in planning is to preserve high quality germplasm with a wide range of desirable attributes in our breeding program. We may be able to find suitable lines from these genetic resources. Every breeder knows the importance of this issue. However, it is hard for a breeder to maintain such a number of barley lines in a limited area with a limited work force. Collaborative breeding may give us a chance of effectively preserving a wider range of useful germplasm than otherwise possible in either partner's gene pool.

Every brewer makes efforts to secure stable supply of quality barley. Sapporo's collaborative breeding is one of the strategies towards its goal. In any case customers should maintain good relationship with suppliers and breeders. However, verbal communication and statistics do not always tell what the market really needs. We believe customers and breeders should visit trial sites together and discuss what to do, and in this way a new variety which meets the market requirements can be developed. In this sense, it is worth having a collaborative breeding program in Australia for Sapporo.

Sapporo has a joint breeding program in Canada under the same philosophy as described above. We would like to continue 'Working Together' with you and develop breeding networks throughout the world to bring benefits to both Sapporo and you all.

### **Acknowledgments**

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