A. Identification:

1. **Crop Kind and Market Class:** Soft White Common Spring Wheat
2. **Selection No's:** SW02064, S0500302L
3. **Proposed Name:** Diva
4. **Pedigree:** Treasure/Wawawai//Louise

B. General Situation

1. **Release Justification:** In 2002, a tragedy occurred for spring wheat breeding programs across the Pacific Northwest due to a stripe rust epidemic that circumvented the race-specific, seedling resistance genes in the most promising new soft white spring wheat (SWS) varieties of that time: Zak (WSU), Nick (WestBred), and Jubilee (UI). In a single year, Alpowa became the only SWS variety grown on a significant number of commercial acres with high-temperature, adult-plant resistance (HTAP) to stripe rust, which is race non-specific and typically more durable than seedling resistance. Even more devastating was that fact that thousands of breeding lines were lost to the pathogen in all regional breeding nurseries, leaving very little material to select future varieties from. Fortunately, WSU's 2006 release Louise has HTAP, and this variety has quickly become the primary SWS wheat in commercial production based on acreage. Neither WestBred nor University of Idaho has released a SWS variety with adequate levels of resistance to stripe rust suitable for production in WA State since 2002. As a result, SWS variety choice options for producers are severely limited.

In the last three years, more than 564,000 acres (90%) of soft white spring wheat acreage in Washington State was sown to three varieties: Nick, Alpowa and Louise. Two of the 3 of these varieties can suffer severe crop losses due to stripe rust under high pathogen pressure. Nick is highly susceptible to stripe rust and anyone who grows it must be prepared to apply fungicide if necessary, which is cost prohibitive in many cases. Although Alpowa has moderate levels of HTAP, its resistance level has proven to be inadequate under heavy inoculum pressure in cool, wet springs. Even though Louise has adequate levels of HTAP resistance to stripe rust and is a high yielding variety with excellent end-use quality and broad adaptation, it is tall and tends to mature later than other varieties, which are undesirable characteristics for spring wheat grown in high rainfall areas. Clearly, we need a broader range of variety options to satisfy production needs across the diverse array of soft white wheat growing regions in Washington State.

We are committed to replenishing the SWS variety options for wheat producers by making durable stripe rust resistance an essential feature of all future variety releases. In 2002, we diversified our breeding approach to not only ensure that our new releases are resistant to stripe rust, but also have high yield potential, high test weight, excellent end-use quality, and when needed, Hessian fly (HF) resistance. We made several significant changes in how we select for stripe rust resistance: 1) All experimental breeding material is screened in CA each year, where new races of the pathogen tend to be first identified in the U.S.; 2) In collaboration with X. Chen, multi-location field screening data is collected from naturally inoculated trials for all experimental material every year using appropriate infection type and disease rating

scales; 3) In collaboration with X. Chen, the seedling and HTAP resistance gene status of all promising candidates are determined through field and greenhouse analyses prior to recommendation for release; and 4) In collaboration with K. Campbell, X. Chen and D. Santra, we identified DNA markers for two HTAP sources (Stephens and Louise), which are being used in combination with markers for known seedling resistance genes to pyramid HTAP and seedling resistance into the same variety using marker-assisted forward breeding strategies.

Based on these efforts, we now have two new SWS varieties that will soon be available for commercial production. The first is **Whit** (formerly WA8008), which was approved for final release in 2008. Whit is targeted for production in the high rainfall regions of Latah and Whitman Counties. It is HF resistant, has high levels of HTAP resistance from the same genetic source as Alpowa, has excellent end-use quality, and has excellent yield potential in the targeted production regions. Whit is significantly shorter in plant height and earlier than Louise, making it more suitable for production in high rainfall zones or with irrigation. Whit is not well adapted to the low or intermediate rainfall zones. We anticipate that Whit will replace a significant portion of the Louise and Nick acreage in the target production regions.

The second is WA8039, which will be named **Babe** if approved for final release in 2009. Babe is intended to be the Alpowa replacement in intermediate to high rainfall zones, where infestation by Hessian fly is not a major concern. Although it originates from the same source, the HTAP resistance in Babe expresses at a higher level than that in Alpowa, perhaps due to the improved seedling resistance in this variety compared to Alpowa. Babe does not suffer from the emergence problems that plague Alpowa, and its end-use quality is superior to that of Alpowa. Babe also is partially resistant to the HF, whereas Alpowa is susceptible. Babe has high test weight and has demonstrated performance stability under moisture stress. Our intention is to remove Alpowa from commercial production by replacing it with Babe.

We have a third new SWS to propose for pre-release this year, WA008090 (referred to as **WA8090** throughout the rest of this request). WA8090 is the most promising spring wheat variety release candidate identified from this program in the last 14 years. WA8090 has several remarkable features including: 1) outstanding grain yield potential across a broad range of production environments; 2) high test weight; 3) outstanding end-use quality; 4) high levels of resistance to the Hessian fly; and 5) high levels of HTAP resistance to stripe rust from the same source as Louise. WA8090 provides an excellent SWS option in the low rainfall zone where the low test weight of Louise can be a concern. Its broad adaptation also overlaps with the target production areas of both Whit and Babe, which would expand variety options for producers in these areas.

Breeders often predict target production areas for new varieties, however, growers define them. Growers will choose which of these varieties best suit their specific production scenarios by trying them on their farms. Our goal was to provide growers with stripe rust resistant varieties to choose from as quickly as possible to ensure the environmental safety and economic viability of soft white wheat production in the region. By 2010, growers will have the opportunity to choose from at least five SWS varieties with HTAP: Louise, Alpowa, Whit, Babe (if approved for final release), and WA8090 (if approved for pre-release). More importantly, the HTAP in these varieties comes from two unique sources, which enhances the

genetic diversity of stripe rust resistance genes deployed in the region. With the release of these new varieties, combined with our efforts to introgress the HTAP resistance from Stephens into spring wheat and to pyramid HTAP with specific seedling resistance genes using MAS, we hope to proactively prevent the stripe rust epidemic of 2002 from ever occurring again.

2. **Use type:** Soft white common cookie, cake and pastry wheat.

3. **Description:** Semi-dwarf, soft white spring wheat with mid-season maturity, common head type, white straw and white glumes.

4. **Intention:** WA8090, which has high levels of HTAP resistance to stripe rust, is targeted to the low (<12 inches), intermediate (12-20 inch average annual precipitation) and high (>20 inch average annual precipitation) rainfall production zones as a complement to Alpowa (moderate HTAP), Louise (high HTAP), Whit (high HTAP), and Babe (high HTAP), and as a replacement for Nick (susceptible). WA8090 also may supplant a portion of the Louise acreage in the low rainfall area due to improved test weight, and the high rainfall area because it is shorter in height than Louise and has superior HF resistance.

C. General Agronomics:

1. **Agronomic performance:** WA8090 was evaluated in preliminary (2 site-years), state (4 site-years), and tri-state (3 site-years) breeding nurseries from 2006 through 2008 (Table 1), and also at fifteen variety testing locations in 2008 (Tables 2-6). Averaged over nine site-years of breeding trial data, grain yields of WA8090 (67 bu/A), Alturas (70 bu/A) and Louise (68 bu/A) were similar (Table 1).

   Based on 2008 variety testing data, the grain yields of WA8090 (28 bu/A) were similar to those of Nick (29 bu/A) and Louise (26 bu/A) and significantly higher than Alpowa (24 bu/A), Whit (25 bu/A) and WA8039 (24 bu/A) in the <12 inch rainfall zone (Table 2), whereas WA8090 (51 bu/A) grain yields were similar to the other check varieties in the 12-16 inch rainfall zone (Table 3). In the 16-20 inch rainfall zone, grain yields of WA8090 (52 bu/A) were significantly higher than WA8039 (47 bu/A) and similar to the grain yields of Whit (53 bu/A), Louise (52 bu/A), Alpowa (51 bu/A) and Nick (49 bu/A) (Table 4). In the greater than 20 inch rainfall zone, grain yields of WA8090 (68 bu/A) were significantly higher than Whit (61 bu/A) and similar to the grain yields of Nick (66 bu/A), Louise (65 bu/A), Alpowa (65 bu/A) and WA8039 (65 bu/A) (Table 5). Under irrigation, yield averages of WA8090 (90 bu/A), WA8039 (106 bu/A), Alpowa (104 bu/A), Nick (92 bu/A) and Whit (90 bu/A) were similar, and all varieties produced more grain than Louise (72 bu/A) (Table 5).

2. Other Agronomic Traits:

a. **Plant height:** WA8090 was 1 to 4 inches shorter than Louise, depending on location (Tables 1-6) and 1 to 3 inches taller in height than Alturas (Table 1) Whit, Nick, Alpowa and WA8039 across locations (Tables 2-6).

b. **Heading date:** Average heading dates of WA8090 were similar to those of Louise, Alpowa and WA8039, and 2 to 4 days later than those of Nick and Whit (Tables 2-6).

c. **Test weight:** Test weight averages of grain from WA8090 were similar to those of grain from Alpowa, Nick and WA8039 and were significantly higher than those of grain from Louise and Whit (Tables 2 through 6).

d. **Grain protein content:** Grain protein content averages of WA8090 were similar to those of Alpowa, Louise and WA8039 and lower than those of Nick and Whit (Tables 2 through 6).

3. **Quality:** See Quality Assessment Report Provided by Morris et al (Pages 7-9). The authors indicate that this variety could be approved for released based on its outstanding end-use quality attributes alone.

4. **Resistance to diseases and insects:**

a. **Stripe Rust:** WA8090 was tested on the Whitlow farm near Pullman and Mt. Vernon in breeding nurseries in 2006 and 2007 (Table 7-8) and on the Spillman, Plant Path, and Whitlow farms near Pullman, Lind, Walla Walla, and Mt. Vernon in 2008 under natural infection of stripe rust (Table 9-10). In these field nurseries, WA8090 was resistant (ITs 1-2) in 2006 and 2008 to moderately resistant (IT 5, 20%) in 2007, similar to its parent, Louise, which has durable high-temperature adult-plant (HTAP) resistance. The susceptible reaction (IT 8) in the early growth stage and resistant reaction (IT 3) in the late growth stage at Mt Vernon indicate that WA8090 has HTAP resistance. When tested in the greenhouse at low temperature cycles (diurnal temperatures gradually changing from 4 to 20°C), WA8090 was resistant (IT 1) to race PST-100, susceptible to PST-127, and had mix reactions (IT2 and 7) to PST-37 (data not shown). Because PST-127 was present in the testing fields in Pullman and WA8090 was resistant in the field nurseries in 2008, WA8090 likely has HTAP resistance, as also supported by the Mt Vernon field data. Testing is underway in controlled greenhouse experiments with more races in seedling and adult-plant stages to confirm the stripe rust resistance gene composition of WA8090.

b. **Leaf Rust:** No data available for assessment.

c. **Powdery Mildew:** No data available for assessment.

d. **Hessian fly:** Based on controlled environment insect screening evaluations conducted at the University of Idaho, WA8090 is moderately resistant (88%) to Hessian fly (HF)[(*Mayetiola destructor* (Say)] biotypes E, F and GP.

e. **Russian wheat aphid:** Based on parentage, this variety should be susceptible to the Russian wheat aphid (*Diuraphis noxia* (Mordvilko)).

5. **Area of Adaptation:** WA8090 broadly adapted to diverse production regions; however, it may be best adapted for production in areas of eastern WA receiving more than 12 inches of average, annual precipitation (intermediate and high rainfall zones).

6. **Weakness:** The primary weakness of WA8090 is that it does not have a distinct yield advantage over Nick in the semi-arid region. The improved stripe rust

resistance compared to Nick and excellent overall end-use quality negate this concern.

7. **FGIS Results:** All fourteen samples submitted to FGIS in 2008 graded soft white.

D. **Seed Source, Status, and Availability:** Heads were collected in the summer of 2008 for Breeder seed production during the 2009 crop year.

E. **Other Comments:** The limited number of soft white spring wheat varieties in commercial production with adequate levels of durable stripe rust and Hessian fly resistance is a serious concern for regional wheat producers, and the release of WA8090 would expand variety options with HTAP and HF resistances for producers to choose from. WA8090 has better HF resistance, higher test weight and is shorter in height than Louise, and has superior stripe rust resistance compared to Alpowa and Nick making it well suited for production in the intermediate and high rainfall zones in conventional and direct seed production. The deployment of varieties with differing stripe rust resistance genes, as is the case for Whit, WA8039 and WA8090, will provide producers with choices that will reduce the likelihood of a repeat of the stripe rust epidemic that occurred in 2002.

F. **Provisions for PVP:** Since WA8090 will be one of only 4 soft white spring wheat varieties in the region with both HF resistance and HTAP resistance to stripe rust, PVP may be warranted.

Assessment of the End-Use Quality of WA8090 Soft White Spring Wheat

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Line designation(s):	WA8090		
Market class/type:	Soft White Spring		
Requesting breeder:			
Release status request:	⊕ Pre-Release	□Full Release	□ Other
Years of quality testing:	4 (Table 11)		
Check varieties:	Alpowa	Alturas	Louise
Maximum paired check comparisons:	6	11	12

INTRODUCTION

Following is an assessment of the quality of WA8090. Assessment of wheat quality involves data interpretation and therefore may vary accordingly. Data are from the Western Wheat Quality Lab and the Washington State University Wheat Quality Program. These data represent standard cultivar development and nursery testing procedures.

Nurseries and the corresponding nursery numbers are described in Table 11. Experimental genotypes are evaluated by comparison to check varieties grown in the same nursery (same location-year) to minimize environmental confounding. Check varieties and their occurrence in various nurseries are listed in Table 12. For statistical purposes a limited number of check varieties are used. These are generally selected on the basis of class, current production, occurrence in nurseries, and known quality attributes. Statistical analyses are conducted as essentially paired t-tests using balanced designs. N (the number of paired comparisons) varies according to the test conducted. Table 13 present the analysis of variance by check variety for each quality parameter. LSDs assume an % = 0.05. Table 14 lists the data used for analysis.

Trait abbreviation	Trait name	Units	Comments
TWT	Test weight	lbs/bu	limits set for U.S. grades
WPROT	Wheat Protein	%	--
SKHRD	Single Kernel Hardness	unitless	--
SKWT	Single Kernel Weight	mg	--
SKWTSD	Single Kernel Weight sd	unitless	--

FYELD	Flour Yield	%	--
BFYELD	Break Flour Yield	%	--
FASH	Flour Ash	%	lower values are preferred
MSCOR	Milling Score	unitless	--
FPROT	Flour Protein	%	--
FSV	Flour Swelling Volume		indicator of partial waxy
MABS	Mixograph Absorption	%	dough water absorption
CODI	Cookie Diameter	cm	--
CAVOL	Sponge Cake Volume	cc	--
LDOPA	L-DOPA	A_{475}	polyphenol oxidase

INTERPRETIVE SUMMARY FOR WA8090
(as compared to Alpowa, Alturas and Louise)

Test weight is greater than Alturas and Louise; similar to Alpowa.

Grain protein is similar to all checks.

SKCS kernel hardness is less than Alpowa and Alturas; similar to Louise.

Kernel weight is greater than all checks and more variable than Alpowa and Alturas.

Flour yield is greater than Alpowa (3%) and Louise; similar to Alturas.

Break flour yield is greater than Alpowa (2.6%) and Louise; similar to Alturas.

Flour Ash is less than Alpowa, Alturas; similar to Louise.

Milling score is greater than all checks.

Flour protein is less than Louise; similar to Alpowa and Alturas.

Flour swelling volume indicates normal starch amylose

Dough water absorption is similar to all checks, trending lower.

Cookie spread is greater than all checks.

Cake volume is similar to Louise (limited data).

CONCLUSION

WA8090 displays very good grain properties and milling properties. Overall mill score is 4.9 points over Alpowa and an improvement over two good milling checks. End-use properties are also very good with a demonstrated improvement over two very good quality checks. Cake data are limited but suggest WA8090 could perform well in cake baking. Release is justified on quality considerations alone.
Overall, release of this variety is expected to:

⊕ increase the overall quality of the wheat crop in Washington

□ exert no positive or negative effect on the overall quality of the wheat crop in Washington

□ have both positive and negative effects on the overall quality of the wheat crop in Washington

□ have both neutral and negative effects.

□ decrease the overall quality of the wheat crop in Washington

□ depend upon the variety that it will replace/supplant, meaning that its effect could be any one or a combination of the outcomes above

□ require special handling, segregation, etc. for the following reason(s):

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