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Vitenskapskomiteen for mattrygghet
Norwegian Scientific Committee for Food Safety

Pest risk assessment of wild oats (*Avena fatua*) as an indirect plant pest in Norway

Opinion of the Panel on Plant Health of the Norwegian Scientific Committee for Food Safety 17.12.08

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SUMMARY

Wild oats (*Avena fatua* L.) are widely spread and constitute a weed problem in Norway. In order to identify proper revision of the current policy on wild oats in Norway (regulation on wild oats, FOR 1988-03-25-251), the Norwegian Food Safety Authority (Mattilsynet) in a letter of 27th March 2007, requested a pest risk assessment from the Norwegian Scientific Committee for Food Safety (VKM). Mattilsynet also asked for an assessment of the probability that other species than *A. fatua* (other wild oats species with saucer-shaped abscission scar) can establish as a weed in Norway. The current opinion of VKMs Panel on plant health (Panel 9) is a pest risk assessment of *A. fatua* in Norway, and is based on a report from the Norwegian Institute for Agricultural and Environmental Research (Bioforsk). The probability of establishment for other wild oats species is assessed in a separate document.

Mattilsynet maintains a database of farm units where wild oats is established, the wild oats register. This database has been used in the Bioforsk report and in the current pest risk assessment.

Panel 9 gives the following main conclusions of the pest risk assessment: 1) Wild oats (*A. fatua*) is widely distributed in all municipalities in the main agricultural areas in south-east and central-east Norway, and in the municipalities close to the Trondheim fjord. Otherwise it is present in only a few scattered municipalities not geographically connected to these main areas. 2) Endangered area not yet infested by *A. fatua* is estimated to 228858 ha. The counties of North- and South-Trøndelag have a higher portion of endangered area not yet infested than south and central part of East Norway. 3) The probability of entry of *A. fatua* from outside Norway is very low. 4) The probability of spread within Norway is high. In areas with low infestation, like Trøndelag, the probability of spread is lower than in heavily infested areas. However, in areas with high level of infestation there are few new farms left to be infested. 5) The official wild oats register is a valuable tool to limit spread and to follow up infested farms. The register would be even more useful if inspection for infestation on new farms had been more systematic. 6) Due to cost efficient herbicides, wild oats is no longer devastating even in cereal monocropping. However, infested area in Norway is increasing. The structural changes in cereal farming result in more farms being managed by entrepreneurs. Fields managed by entrepreneurs promote use of herbicide even on small infestations, since this is a cost effective control measure. Less official control of cereal fields can also be expected. The economical consequences are thus expected to be high. The economical consequences can be even higher in organic farming, if the most profitable rotation has to be changed to a less profitable one because of wild oats infestation. 7) Uncertainty factors: Uncertainties concerning the processes of entry, establishment and spread are considered as low. The direct economic consequences have low uncertainty. The indirect economic consequences have a moderate level of uncertainty. Uncertainty in the wild oats database constitutes the main source of uncertainty in this pest risk assessment.

ASSESSED BY

Persons working for the Norwegian Scientific Committee for Food Safety (Vitenskapskomiteen for mattrygghet, VKM), either as appointed members of the Committee or as *ad hoc*-experts, do this by virtue of their scientific expertise, not as representatives for their employers. The Civil Services Act instructions on legal competence apply for all work prepared by VKM.

Panel 9:

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ACKNOWLEDGEMENTS

VKM has asked the Norwegian Institute for Agricultural and Environmental Research (Bioforsk), Plant Health and Plant Protection Division, to make a draft pest risk assessment report on *Avena fatua* as an indirect pest in Norway. VKM has used this report (Netland et al. 2008a) as a basis to answer the request from the Norwegian Food Safety Authority (Mattilsynet).

Jan Netland, Helge Sjursen and Trond Rafoss are acknowledged for their valuable work with the draft pest risk assessment report.

CONTENTS

1. BACKGROUND

Wild oats (*Avena fatua* L.) are widely spread and constitute a weed problem in Norway. Wild oats compete strongly with cereal crops because of their similar biology and growth habit, and the weed can cause significant crop yield losses when left unmanaged. Wild oats are spread via seeds only, and they are closely related to common cultivated oats *(Avena sativa)*. A hybridization of wild and cultivated oats can make fertile offspring. The hybrids have a high portion of dormant seeds that can survive in the soil for many years without germinating.

The Norwegian Food Safety Authority (Mattilsynet) has a register comprising all properties where wild oats has been found. 9526 agricultural properties were registered with wild oats by the end of year 2005. *Avena fatua* is the only species of wild oats that via the registrations so far has shown to be a weed problem in Norway.

Wild oats have been officially controlled since the 1950ies. Today the regulations are founded on the Norwegian food law (LOV 2003-12-19 nr 124). Most regulations concerning wild oats are gathered in the regulation on wild oats, "FOR 1988-03-25 nr 251: Forskrift om floghavre" (Attachment 1). Wild oats are also controlled via regulation on seeds (FOR 1999-09-13 nr 1052).

Regulation on seeds are harmonized with EUs set of rules on the area. Mattilsynet is not considering changing these regulations. However, Mattilsynet is planning a revision of regulation on wild oats. First of all Mattilsynet wishes to extract decisions that concern seeds, to collect all these decisions in regulation on seeds.

The current regulations on wild oats have many decisions, and the authorities are uncertain how appropriate some of them are. Not all decisions are of the same importance in relation to spread of wild oats, and the authorities are considering removing the decisions with little relevance and instead increasing the focus on what they consider as important. However, Mattilsynet finds that it is not obvious which decisions are important. Also, some of the decisions might be important in relation to wild oats when considered in isolation, but can be unsuitable from several reasons. Mattilsynet therefore wishes a full risk assessment of wild oats in Norway.

In order to revise the current policy on wild oats in Norway, Mattilsynet, in a letter of 27th March 2007, requested a pest risk assessment from VKM. To answer the request from Mattilsynet, VKM commissioned two separate draft pest risk assessment reports from Bioforsk. The first is a draft pest risk assessment of *A. fatua* (Netland et al. 2008a), and the second is a draft assessment of the establishment potential of winter wild oats (Netland et al. 2008b). Both draft assessments have been used as a basis for the opinion of VKMs Panel 9. The current document is a pest risk assessment of wild oats (*A. fatua*) and is based on the first report from Bioforsk. The probability of establishment for other wild oats species is assessed in a separate document (VKM 2008).

Be aware that the current document is a pest risk assessment, and not a Pest Risk Analysis (PRA). A PRA consists of both a risk assessment and a risk management part. VKM performs purely the risk assessment, whereas Mattilsynet is responsible for the risk management. However, since this pest risk assessment is part of a PRA process, the current document refers to the PRA term in several contexts, like the identification of the PRA area and referrals to former PRAs. This is in accordance with the international standard ISPM No. 11 (FAO 2004).

2. TERMS OF REFERENCE

Mattilsynet requests a pest risk assessment of wild oats, *Avena fatua* L. as an indirect plant pest in Norway. The pest risk assessment should be made according to ISPM No. 11 (FAO 2004). The pest risk assessment should also include an assessment of the probability that other species than *A. fatua* (other wild oats species with saucer-shaped abscission scar) can establish as a weed in Norway.

3. INITIATION

3.1. Initiation points

3.1.1. PRA initiated by the review or revision of a policy

This assessment was initiated by Mattilsynet as a basis for a review and possible revision of a policy, in order to identify proper revision of the current policy on wild oats in Norway.

3.2. Identification of PRA area

The PRA area is Norway.

3.3. Information

Information sources utilised for this pest risk assessment are published material available in international scientific journals, books and reports, and on the Internet, and personal communications and geographic data that have been made available to the risk assessors. Where these information sources have been used, this is indicated in the text by references enclosed in brackets.

This pest risk assessment is made in accordance to the international standard ISPM No. 11 (FAO 2004).

3.3.1. Previous PRA

No previous pest risk assessments or PRAs exist for the pest *A. fatua* for the PRA area. *A. fatua* is mentioned in various commodity pest risk assessments for other PRA areas (AQIS 2000). Other pest risk assessments or PRAs for *A. fatua* are not known.

3.4. Conclusion of initiation

The pest of concern in this pest risk assessment is *Avena fatua* L. The initiation point for this pest risk assessment is the review or revision of a policy by Mattilsynet. The PRA area is Norway. No previous pest risk assessments or PRAs are known that can replace or be used in this assessment.

4. PEST RISK ASSESSMENT

4.1 Pest categorization

4.1.1. Identity of pest, name and taxonomic position

4.1.1.1 Name

Avena fatua L. (Lid & Lid 2005)

4.1.1.2 Synonyms

None

4.1.1.3 Common names

Wild oats (English)

Folle avoine (French)

Flughafer (German)

Floghavre (Norwegian)

Flyghavre (Swedish)

Flyvehavre (Danish)

Sources: Nordic languages (Jensen et al. 1993), Norwegian and English (Korsmo et al. 2001), Nordic languages, English and German (Madsen & Jakobsen 2004).

4.1.1.4 Taxonomic position

Poaceae (Lid & Lid 2005).

4.1.1.5 Bayer computer code

AVEFA

Figure 1. Drawing of wild oat Avena fatua L by Korsmo et al. (2001)

4.1.1.6 Identification of the pest

The fruit of wild oats is a nut, tightly enclosed by two thin 'leaves' or shells (*lodiculae*), the lemma and palea (Figure 1, b2). Such shells facilitate the pollination in many genera within the family *Poaceae*. They are probably rudimentary petals (Dahle 1990). Ordinary oats, *Avena sativa* L., can sometimes form 'fatuoides', which morphologically look like wild oats, because their lemma have a stoat and the seeds have saucer-shaped abscission scar. The fatuoides are mutants of ordinary oats. The formation of fatuoides makes the control of cereal fields more difficult (Eklo et al. 1998), but seed dormancy in fatuoides is reported to be at the same level as in ordinary oats seeds. Wild oats seeds have been found to have significantly higher dormancy than seeds of fatuoides and ordinary oats seeds (Johansen 1995). This behaviour indicates that the probability that fatuoides may be a potential weed problem is low.

Correct description of wild oats vs. fatuoides is therefore important to enable us to detect the true wild oats. Fatuoides and ordinary oats have small side lobes on these shells, while wild oats lack such side lobes (Dahle 1990; Eklo et al. 1998). Seeds of fatuoides are usually bigger and thicker than seeds of wild oats (Haugsten 1993b).

The spikelets of wild oats, subspecies and fatuoides can be identified by methods published by Eklo et al. (1998) – see also Dahle (1990). Korsmo et al. (2001) and Lid & Lid (2005) have published a more general identification of the whole plant, including the flowers and the spikelets.

The shape and appearance of the fatuoides differ with oats variety (Table 1). The varieties with big open panicle have fatuoides that can be mistaken for being wild oats. Therefore, details from the investigation of Eklo et al. (1998) based on common varieties of *A. sativa* and their corresponding fatuoides are given in table 1.

Table 1. Morphological description of the varieties of oats Avena sativa and their corresponding fatuoides (Eklo et al. 1998; Lid & Lid 2005).

Species	Subspecies	variety	Description
A. sativa	*A. sativa* *Thell*	*Kapp*	Relatively short and closed panicle ('sativa-type'). Stout awn on all the grains in the spikelet. Scar with a tap. *Lodiculae* with side lobe. Many short hairs on the nodes with few single hairs at basis.
		Ramiro	Open, big panicle with broad leaves. All spikelets with awn on the first grain. Scar with a tap. *Lodiculae* with side lobe. Lack hairs on the nodes and the leaves.
		Olram	Single plants with open, big panicle. All spikelets lack awn. Scar with a tap. Lack hairs on the nodes and the leaves.
		Celsia	Relatively open and slender panicle. All spikelets with awn on the first grain. Scar with a tap. *Lodiculae* with side lobe. Lack hairs on the nodes and the leaves.
			Description in summary: *'Kapp'* distinguish from the other types by the narrow panicle and the hairy nodes. The other types have open and big panicles. In addition *'Ramiro'* and *'Celsia'* often have awn on the first grain in the spikelet.
A. sativa	*A. sativa* *Thell - fatuoides*	*Kapp fatuoides*	Relatively short and closed panicle ('sativa-type'). Lack or only a short awn on the first grain in the spikelet. *Lodiculae* with side lobe. Many short hairs on the nodes with few single hairs at basis.
		Ramiro fatuoides	Open, big panicle with broad leaves. Spikelets with awn on all grains, which have saucer-shaped abscission scar. *Lodiculae* with side lobe. Lack hairs on the nodes and the leaves.
		Olram fatuoides	Single plants with open, big panicle. All grains in the spikelet have awn. Lack hairs on the nodes and the leaves.
		Celsia fatuoides	Relatively open and slender panicle. All spikelets with awn on all the grains. *Lodiculae* with side lobe, some very big. Lemma smooth. Hairs on the leave edges.
		Lena fatuoides	Relatively open and slender panicle. All spikelets with awn on all the grains. Lemma smooth. *Lodiculae* with side lobe. Lack hairs on the nodes and the leaves.
		Svea fatuoides	Panicle varying from closed 'sativa-type' to open 'wild oats-type'. Spikelets with awn on all grains, which have saucer-shaped abscission scar. *Lodiculae* with side lobe. Lack hairs on the nodes and the leaves.

The fatuoides have spikelets with awn on all the grains with saucer-shaped abscission scar. Apart from this, the morphology is the same as for the corresponding, 'oats variety', including the form of the panicle, the hairy nodes, leaf edges and basis. Because the side lobes can vary in size, dependent of the developing stage, it is sometimes difficult to identify the variety. The

most frequent oats varieties and fatuoides today are Olram, Celsia, Lena, Bessin, Biri, Roope and Belinda (Monge, pers. communication 2007).

The morphological description given in table 2 can be used for visual identification of wild oats with its different varieties. The lack of side lobes is the best criterion for wild oats, even though some wild oats seeds have side lobes. These are most likely crosses between wild oats and cultivated oats. Thus, the determination should not rely entirely on this criterion but should be supported by other criterions, as indicated in the table. If only seeds are available, the seeds should be sown in greenhouse to study the panicle shape (Eklo et al. 1998). The most frequent variety is Vilis (Monge, pers. communication 2007).

Table 2. Morphological description of the different forms of wild oats A. fatua (Eklo et al. 1998; Lid & Lid 2005).

Avena fatua L.	Forms	Description
	*Pilosissima*	Slender, open panicle. The spikelets awn on all the narrow grains, which have saucer-shaped abscission scar. Brown, long hairs on the lemma and the abscission scar. Pointed, narrow *lodiculae* without side lobes. Some plants have hairy nodes, leaf edge and basis.
	*Intermedia*	Slender, open panicle. The spikelets awn on all the narrow grains, which have saucer-shaped abscission scar. Brown, long hairs on the lemma, but short hairs at the abscission scar. Lemma with few, single hairs. Elsewhere as *pilosissima*.
	*Glabrata*	Slender, open panicle. The spikelets awn on all the narrow grains, which have saucer-shaped abscission scar. Mature plants have yellow-grey, rough lemma without hairs, but long hairs at the abscission scar. None of the investigated plants had hairy nodes. Only infrequent hairs on the leaf edges. Pointed, narrow *lodiculae* without side lobes.
	*Vilis*	Slender, open panicle. The spikelets awn on all the narrow grains, which have saucer-shaped abscission scar. Mature plants have yellow-grey, rough lemma without hairs, but short hairs at the abscission scar. None of the investigated plants had hairy nodes. Only infrequent hairs on the leaf edges. Pointed, narrow *lodiculae* without side lobes.

Other methods than visual identification based on morphological characteristics have been evaluated. DNA-based analysis as possible identification method for wild oats was evaluated by Eklo et al. (1998). They concluded that the sensitivity of the method could be improved by using single plant samples instead of bulk plant samples. Fatuoides can thereby be detected. DNA-methods are not yet in commercial use in Norway (Tangerås, pers. communication 2007). The DNA-methods described by Eklo et al. (1998) have not been further developed (Klemsdal, pers. communication 2007).

NIR (near infrared reflection)-methods were also evaluated by Eklo et al. (1998) for the purpose of wild oats identification. The conclusion was that the NIR-method could not distinguish 100% between the groups, ordinary oats, wild oats and fatuoides. However, the results of the evaluation were promising, and further development of the methods was recommended.

4.1.2 Presence or absence in PRA area

According to official records held by Mattilsynet wild oats is present in 155 out of 431 Norwegian municipalities. The distribution of wild oats in Norway is shown in figure 2. As shown in the figure wild oats is present in all municipalities in the main agricultural areas in south-east and central-east Norway. It is also widely distributed in the municipalities close to the Trondheim fjord. Otherwise wild oats is present in only a few scattered municipalities not geographically connected to these two main areas.

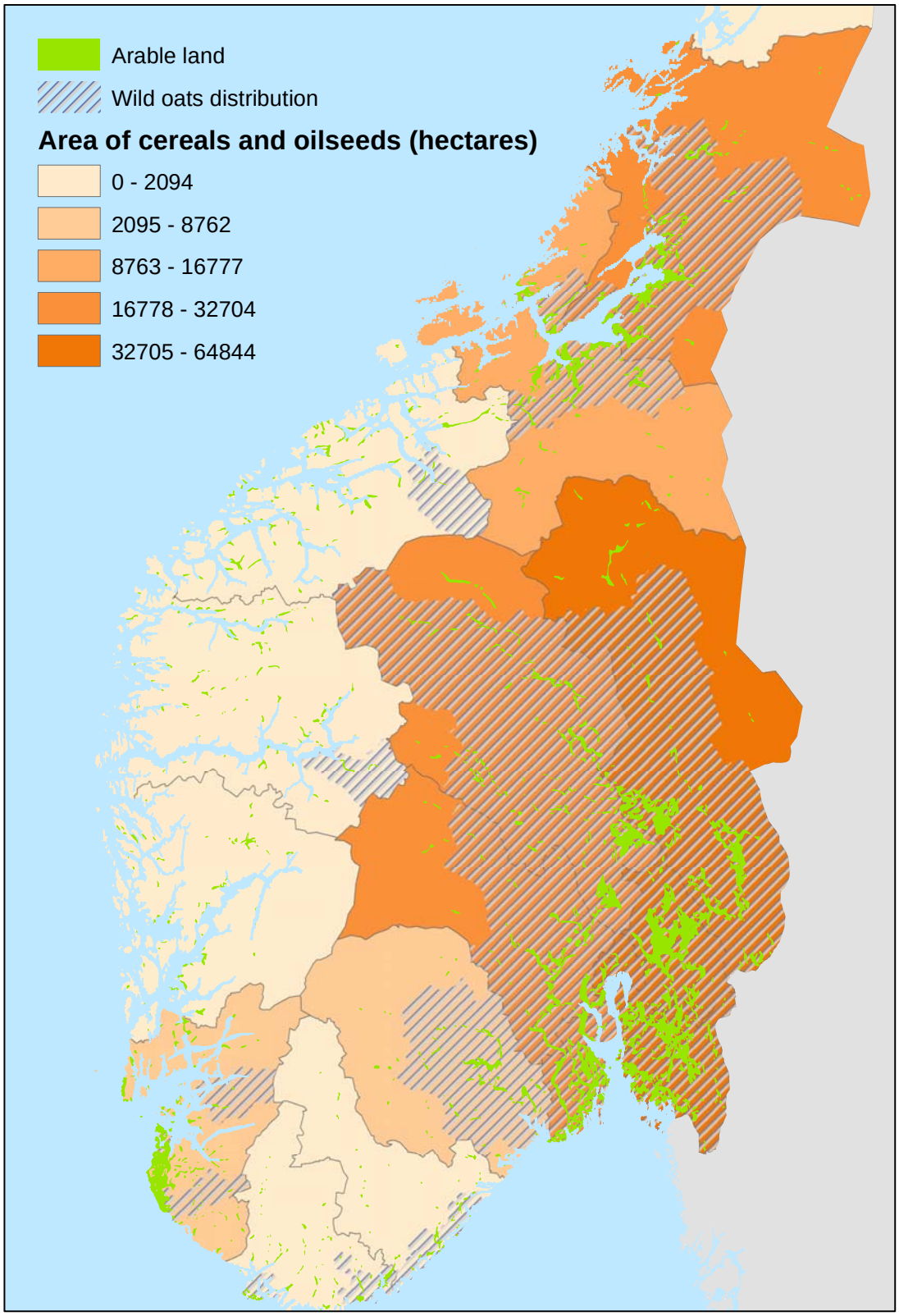

Figure 2. Areas in Norway with official records of wild oats (shaded). The spatial resolution of the records is based on municipalities. The amount of arable land in hectare in the different counties is indicated by different colours. The agricultural area is coloured green

4.1.3 Regulatory status

Norway: *A. fatua* is classified as a malignant weed in Norway. Provisions related to wild oats in Norway are founded in the act of 2003-12-19 No. 124, relating to food production and food safety ("Matloven"), and specified in the wild oats regulation (Attachment 1).

According to the wild oats regulation (Attachment 1) the property owner or user that has the knowledge or the suspicion that wild oats is present on a property, has to report this to the municipal agricultural administration, which again reports to the agricultural county administration and Mattilsynet. This message must be accompanied by a plant sample. If Mattilsynet confirms that the sample is wild oats, the property owner or user can require official inspection to determine the extent of the occurrence and assess other conditions of relevance to control the weed. If the sample proves to be wild oats, the farm will be included in the wild oats database. Mattilsynet, the county and municipal agricultural administration is required to give advice and guidance on measures to eradicate this weed.

As a tool for fulfilment of the wild oats regulation (Attachment 1), Mattilsynet maintains a database of farm units where wild oats is established, the wild oats register ("floghavrelista" in Norwegian). Farms included in this database have certain limitations and obligations in management and flow of product from the fields specified in the wild oats regulation (Attachment 1). This database is also a tool for selection of candidates for contract areas for production of certified cereal seed and whole oats for horse feed. The effect of several restrictions in the wild oats regulation (Attachment 1, §§ 6 and 7) depends on the validity of the wild oats database. To be an effective tool it is important that the database covers the actual spread as accurately as possible. In the present pest risk assessment the database is used extensively and some of the conclusions may be misleading if the database is not correct. Therefore, the database has been evaluated as part of this pest risk assessment (see section 4.2.4).

Wild oats is also regulated in the seed regulation, FOR 1999-09-13 nr 1052. Regarding wild oats, FOR 1999-09-13 nr 1052 comprise certified cereal seed and herbage grasses with large sized seed. Wild oats should neither be found by inspection of the actual area contracted for cereal and grass seed production, nor on area where the same combine harvester is used. The national seed regulation is harmonised with the EU legislation. Certificates issued by the export country state that that specific measures have been carried out to ensure that the actual seed lot is not contaminated with wild oats.

4.1.4 Biological characteristics of the pest

4.1.4.1 Interaction host/pest

Wild oats competes strongly with cereal crops because of their similar biology and growth habit, and the weed can cause significant crop yield losses when left unmanaged. A single wild oats plant is capable of producing from 20 to over 150 seeds, depending on the competitive ability of the crop (Maxwell et al. 2007). 400 seed m^{-2} of wild oats can e.g. result in 68% yield loss in wheat and 46% yield loss in barley if wild oats and crop plants emerge on the same day (Figure 3; O'Donovan & Sharma 1983; Haugsten 1992, 1993a). For each day wild oats emerge before the cereal crop, yield loss increase by approximately 3% (O'Donovan et al. 1985). Haugsten (1993a) reported 200-300 wild oats plants m^{-2} in unsprayed plots in a cereal crop. The yield was then 2.7 tons ha^{-1}. Application of herbicide resulted in 4.0 tons ha^{-1}grain yield. The yield reduction (1.3 tons ha^{-1}) compared with crop without wild oats constitutes about 32.5%, which is in accordance with the results of O'Donovan & Sharma (1983).

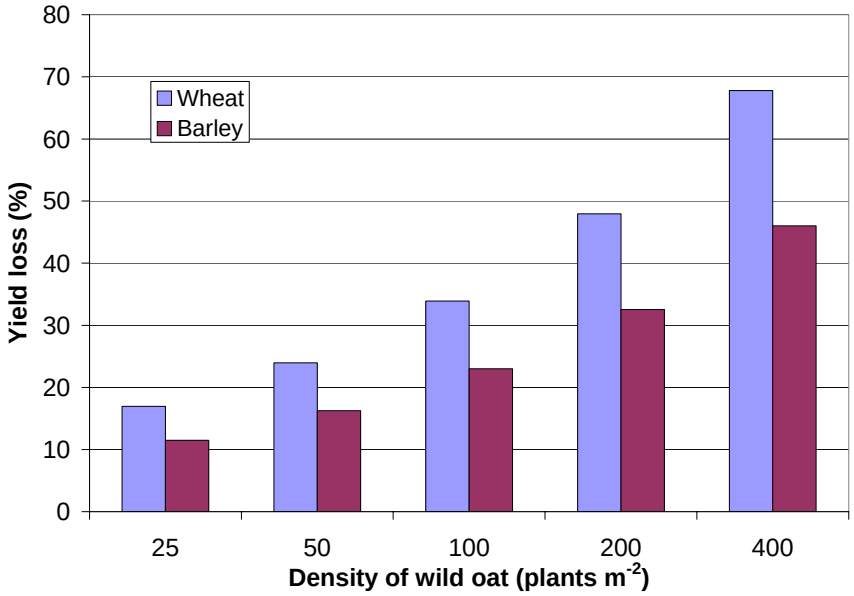

Figure 3. Yield loss of wheat and barley with increasing density of wild oats, compared with no wild oats plants (after O'Donovan & Sharma 1983; see also Haugsten 1993a).

Recent field experiments have also been conducted by O'Donovan et al. (2006) in Alberta, Canada, to determine if spring wheat (*Triticum aestivum* L.) seeding rate influence the effects of recommended and reduced herbicide rates on wild oats shoot mass, seed in the seed bank, wheat yield and economic return. Their results indicate that seeding wheat at relatively high rates (75 – 150 kg ha^{-1}) can contribute positively to herbicide performance, and result in a better wild oats management and higher wheat yields and economic returns. It was possible to reduce the recommended herbicide rate from 100 to 75% without economic consequences. Reducing rates below 75% always resulted in higher wild oats shoot biomass and seed production, even at higher wheat seeding rate.

4.1.4.2 Seed bank studies

Fykse (1970) reported a tendency of higher number of dead wild oats seeds in the soil under open arable fields than under grass leys after 3.5 years. He suggested that wild oats seeds will survive maximum 5 years in dry inland regions, but 6-9 years in moist regions. Miller & Nalewaja (1990) found that seeds persisted longer at greater depth and at low N levels in soil. These studies demonstrate the weed characteristics of wild oats. The seed dormancy enables the species to survive sub optimal conditions like 4 year periods of grass leys. The dormancy also prevents the majority of the dispersed wild oats seed from germinating in autumn and thus extinction by frost through the winter is avoided.

In an 11-year study, during transition from conventional to organic cereal production, Maxwell et al. (2007) investigated the effect of a single pulse of wild oats seeds (0, 20, 80, 320 and 800 seeds m^{-2}) in 1993 on the subsequent seed bank dynamics. In 1994 seed bank densities in response to the pulse were as much as 11 times higher than control plots that received no seeds in 1993. This shows the potential the weed has to increase the seed bank if

seeds are spread every year. By 1996, three years later, after mechanical fallowing of all the cropping systems, the wild oats seed bank was not significantly different from densities in control plots regardless of the size of the initial seed pulse, and remained so through 2004. Their results suggest that increases in wild oats seed inputs during the organic transition period will have relatively few long-term agronomic effects on the dynamics of wild oats seed banks in such systems. The authors also suggest that wild oats seed banks may be constrained by factors other than cropping sequence, when herbicides are not used, such as possible density-dependent regulation as a result of increased soil pathogen attack and seed predation.

4.1.4.3 Spread

By animals

Haugsten et al. (1991) found that whole, viable seeds of wild oats can survive for 48 hours through the digestion channel of cows, goats and horses. In their investigation they also found that if seeds of wild oats were treated mechanically or heated at 80^{o}C, they lost their germination ability.

Wild bird and animal feeding in or passing trough cereals fields with wild oats infestation, may also represent a pathway of spread. It is however very difficult to quantify this pathway.

By transport

Seeds of wild oats may blow away from the top of the grain loads during transport from the farm to the grain mill (Haugsten et al. 1991). Usually such loads are covered, reducing the risks of spread during transportation. It is very difficult to quantify this pathway for spread.

By baled grass silage

A successful conservation by lactic acid bacteria provides anaerobe conditions at pH 4.2 or lower, and low levels of NH_3-N (Nørstbø & Lied 2003; Selmer-Olsen 2001). The germination ability of wild oats seeds when kept at such conditions has not been tested. A Danish investigation showed, however, that seeds of wild oats lost the viability after 5 days in anaerobic conditions at 35°C and after 22 days at 20°C (Jensen et al. 1993).

By baled straw

All bales of grain and straw from weedy fields always contained some seeds (Wilson 1970; Jensen et al. 1993) and represent a possibility for spread.

By sludge

Wild oats seeds will not survive ordinarily treated sludge from sewage, treated with high pH and/or high temperature (Sjursen et al. 2003).

By VEAS-biosolids

VEAS-biosolids are intended as fertilizers and soil improvers in agriculture. During the possessing the seeds of wild oats (and a potato cyst nematode) were treated at 78-81°C for 145 minutes and pressure between 4.5 and –0.92 bars. No wild oats seeds survived the treatment (Magnusson et al. 2000).

By compost

After 2 weeks of windrow composting at temperatures of 50-65°C, 1% of wild oats seeds survived, but after 4 weeks all were killed (Tompkins et al. 1998). In a compost reactor no wild oats seeds survived at essential anaerobic conditions at 40-50°C and 50-70°C during 4-6 weeks (Lystad & Netland 2001).

By trading of whole oats seeds

Many grain seed farmers are concerned about illegal import of whole oats seeds for animal food, and dissemination of wild oats seeds (Mattilsynet 2005).

4.1.4.4 Survival

(See section 4.1.4.2 on seed bank studies and section 4.1.4.3 on spread)

4.1.4.5 Control

Preventive control

Haugsten (1992; 1993) has described several control methods. One of these is use of certified seeds with no wild oats seeds (Bond et al. 2007).

Farm machines and other tools

Spread can be avoided if farmers clean their harvesters and other harvesting machinery for wild oats seeds (Bond et al. 2007). Spread can also be avoided if seed-cleaning machinery is operated correctly and all the wild oats seeds removed by seed cleaners are destroyed by heat treatment and not fed to stock or tipped onto the manure heap or places where it can be transported further by animals, birds and water flow.

Manure

Treating pellets used as feed as described by Haugsten (1993a) killed all wild oats seeds see also ”By animals” in section 4.1.4.3).

Ammonium treated straw remains

Grain waste ammonium treated for 8 weeks or longer inactivated wild oats seeds. Four weeks of treatment was considered insufficient (Fykse & Johansen 1995). Because of the evaporation of the ammonium the temperature dropped to minus 30-40°C, slowing down the inactivation process. More concentrated grain waste need longer ammonium treatment time.

Straw and haulm

The wild oats regulation (Attachment 1) prescribes to treat straw and haulm with NH_3 to avoid spread from these products. The regulation also prescribes covering untreated material if transported from the field.

Transport

The wild oats regulation (Attachment 1) prescribes to cover grain load during transport to avoid dissemination of wild oats seeds.

Manual methods

Hand-roguing of cereals is possible with weed populations of up to 400-500 wild oats plants ha^{-1}. Roguing would take 2.5 to 5 men hour ha^{-1}. Wild oats plants must be removed completely. Otherwise the remaining tillers will be encouraged to produce panicles. Destruction of hand-pulled wild oats plants, even with green panicles, is important (Bond et al. 2007).

Cultural methods

Use of grass ley in more than 4 years will reduce viable seeds sufficiently in the seed bank (Fykse 1970). Growing two or more cleaning crops (e.g. rye-grass and forage rape), which are harvested before the wild oats ripens, reduces the dissemination of wild oats (Haugsten 1993). Wild oats are, however, much less of a problem on farms that practice crop rotation, especially one that includes cleaning and root crops (Bond et al. 2007). Due to less cereal monocropping in organic farming, the wild oats problem may be less than in conventional cereal monocropping. Use of autumn crops will also reduce the frequency of wild oats (Haugsten 1993a).

Chemical methods

In for example potatoes and oil seed crops it is possible to use graminicides like Focus Ultra (cycloxydim) for wild oats control. In wheat and barley the only approved wild oats control herbicide in Norway at the moment is Puma Extra (fenoxaprop-P-etyl + mephenpyr-dietyl) applied at the 4-5-leaf-stage of the cereal plant (Plantevernguiden 2007; VIPS 2007).

4.1.5 Potential for establishment and spread in PRA area

Cereal crops are grown in large parts of the PRA area (Table 3). Since wild oats thrives in cereal cropping (Figure 2) it has a large establishment potential. Data on establishment of wild oats in the PRA area tell that the highest proportion of infested farms are located in area with high density of arable land (Figure 4) and high levels of cereal growing (Table 3). The intensity of cereal crops in the crop rotation seems to be the main reason for high wild oats establishment. Wild oats is spread and established throughout the cereal growing areas, although the proportion of infested farms is low in some regions, mainly due to a high portion of grassland in the crop rotation. From this it can be concluded that no biotic or climatic limits will prevent establishment and spread of wild oats where cereals are grown within the PRA area.

Table 3. Area and number of farms infested with wild oats in Norwegian counties. Total area of oil seeds and cereals is included for comparison.

County	Agricultural land with wild oats (ha.)	Number of farms with wild oats	Total area of cereals and oil seeds 2005 (ha.)
Østfold	26793	1717	63146
Hedmark	14295	1338	58424
Oslo og Akershus	20918	1379	64844
Oppland	8099	891	23641
Vestfold	12333	954	29512
Buskerud	12658	883	25413
Nord-Trøndelag	3258	220	32704
Sør-Trøndelag	1364	217	16777
Telemark	3247	349	8762
Aust-Agder	10	14	1099
Rogaland	49	22	4089
Vest-Agder	2	11	949
Sogn og Fjordane	1	1	61
Møre og Romsdal	1	1	2094
Hordaland	0	0	24
Nordland	0	0	347
In total	103028		331886

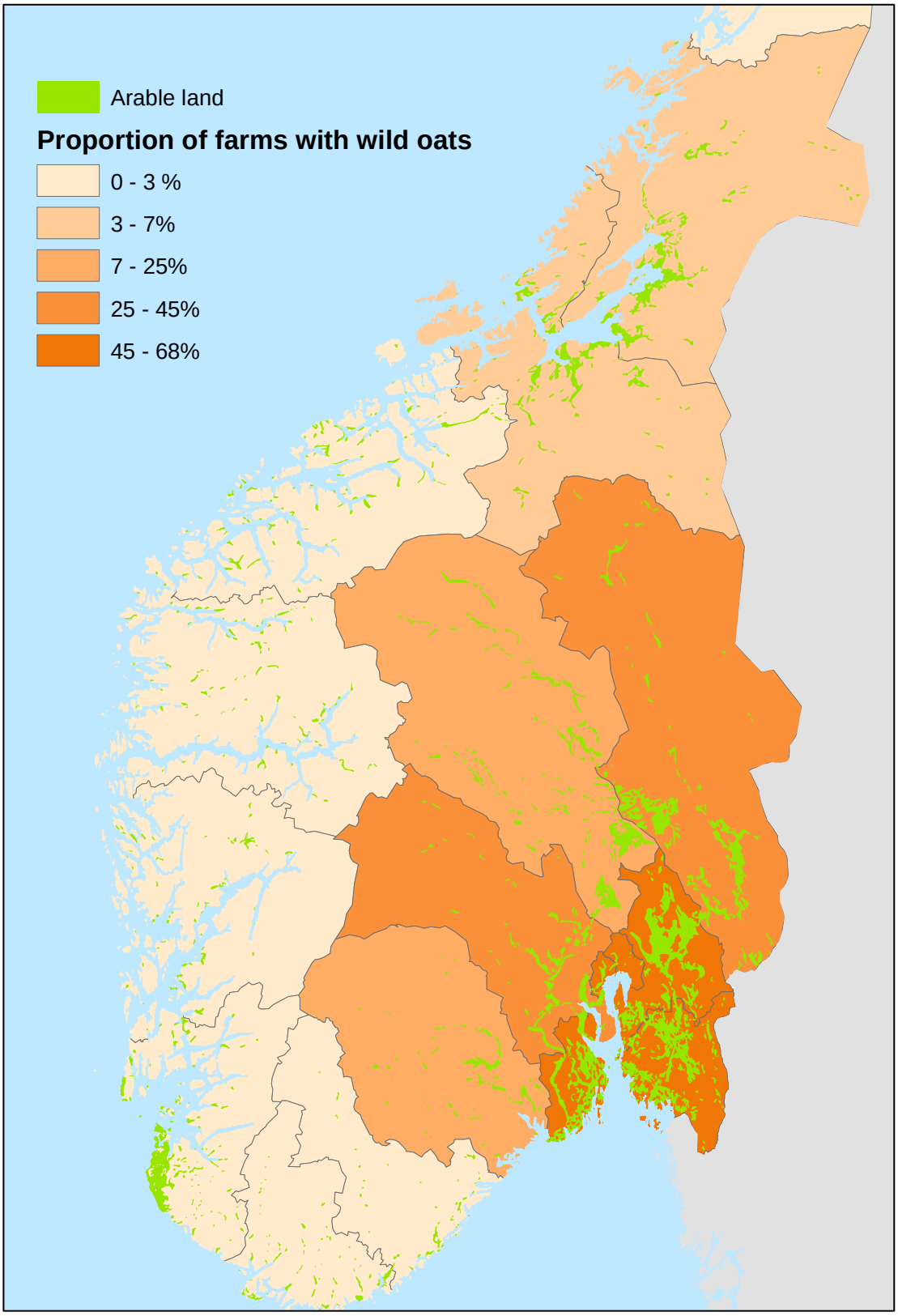

Figure 4. Proportion of farms with wild oats. (spatial resolution on county level) Area with green colour is agricultural land.

4.1.9 Potential for economic consequences in PRA area

Auld & Tisdell (1987) in eastern Australia have proposed the threshold value, for when it is economically sound to control wild oats, to be at 8 plants m^{-2} based on an extended critical density/weed control model. However, contamination of the cereal grain with wild oats seed may reduce the value of the crop more than the model anticipates (Bond et al. 2007). According to the Norwegian regulation on wild oats (Attachment 1), the farmer is obliged to control wild oats.

Yield depression effect of wild oats was shown by Haugsten (1993a). He reported 200-300 wild oats plants m^{-2} in unsprayed plots in a grain crop in Norway and the yield was then 2.7 tons ha^{-1}. Application of herbicide resulted in 4.0 tons ha^{-1}grain yield. The yield reduction (1.3 tons ha^{-1}) compared with crop without wild oats constitutes about 32.5%, which is in accordance with the results of O'Donovan & Sharma (1983).

Historically, wild oats in connection with cereal monoculture has had devastating effects. It has been reported that people had to give up their farm due to the pest (Jensen et al. 1993). More recent information also by Jensen et al. (1993) estimated annual total expenses, including public control, weeding and spraying against wild oats, performed by farmers, as well as expenses for fine grinding of forage grain aiming at destroying eventually occurring grains of wild oats, for the Nordic countries: Denmark > 100 mill. DKK, Finland > 50 mill. FIM, Iceland 0, Norway 5-7 mill. NOK, Sweden 70 Mill. SEK.

4.1.6 Conclusion of pest categorization

The wild oats constitutes a plant health risk in the PRA area, particularly in cereal monoculture. Wide spread of the weed will have adverse economic effects and probably negative environmental consequences, because the weed is competitive and the main control measure in cereal monoculture will be chemical herbicides. Due to this conclusion and that wild oats in addition is a regulated pest, the pest risk assessment process is continued.

4.2. Assessment of the probability of introduction and spread

4.2.1 Probability of entry of the pest

4.2.1.1 Identification of pathways

Identified pathways, i.e. any means that allows the entry of wild oats, are listed in table 4. The main way of entry of wild oats is in the form of seeds. Entry of wild oats in the form of live plants along these pathways is negligible. Assessment of the individual pathways for entry (i.e. movement of wild oats from outside and into the PRA area) is treated in this section, while spread (i.e. movement of wild oats from infested to non-infested areas of the PRA area) is treated in section 4.2.3.

Table 4. General pathways for entry of wild oats

Pathway
Use of cereal seed and seed of grasses (with large sized seed) contaminated with wild oats
Whole grain, pea and seeds
Unthreshed grain, Christmas sheaves, straw, seedstraw, milling waste, chaff
Soil and plants with soil
Compost
Manure
Harvesting equipment and machinery

4.2.1.2 Probability of the pest being associated with the pathway at origin

According to current phytosanitary regulations (section 4.1.3), the pathways for entry currently open are (1) the import of seeds as bird seeds, (2) import of cereal straw and sheaves and (3) import of cereal seed and grass seed. They are listed in table 5. Even if the probability of the pest being associated with the pathway at origin is rated as high, the risk of entry from outside PRA area can be rated as low. While the import of cereal seed is negligible in volume (Source: Kimen Såvarelaboratoriet), as well as the import of cereal straw and sheaves, the import of seeds for birds feed is substantial. Feeding of wild birds during winter is a common tradition in Norway. Seeds, and especially sunflower seeds, are used for this purpose. Most of these seeds are imported

Table 5. Possible pathways for entry of wild oats

Pathway	Probability of the pest being associated with the pathway at origin	Risk management regulations in force	Efficiency of regulations assessed by Mattilsynet	Probability of entry into the PRA area
Grain and seeds marketed as feed for birds without economic importance as livestock	High	1 kg sample per 25 ton sampled by exporter and sent to Norway for analyses	Currently, these goods can be imported on other tariffs not requiring wild oats analysis.	Medium
Sheaves and straw	High	Production site controlled free of wild oats by officials for the actual growing season	Proven difficult in practice to get authorities in exporting countries to issue such documentation	Low
Cereal and grass seed	High	Seed regulation (FOR 1999-09-13 nr 1052) and harmonized with EU legislation	No specific objections	Low

About 15% of the tested lots of imported seeds for birds are infested with wild oats (Table 6). The available data show that the frequency of infested lots has remained relatively stable. There is very little knowledge on whether this activity result in germination of wild oats plants in the surroundings of the feeding site or on fields. Moreover, public awareness of wild oats and knowledge of wild oats regulations is low. The Dutch Plant Health Authority has decided to carry out an investigation to measure weed seed content and viability in bird seeds (information given to the EPPO Panel for Invasive alien species).

Regarding the pathway of cereal seed, Bond et al. (2007) refers to several reports on contaminated cereal seed in the UK. Seed samples and drill box surveys show that 10-20% of the cases had wild oats contamination.

Table 6. Findings of wild oats in samples of seeds for birds imported into Norway in the period 1999 – 2006. Source: Kimen Såvarelaboratoriet AS, Norway

Year	1999	2000	2001	2002	2003	2004	2005	2006
Findings	35	43	75	54	78	39	58	67
Total number of samples of seed for birds	290	322	407	448	463	349	402	458
% sample with wild oats imported bird seed lots	12.1	13.4	18.4	12.1	16.8	11.2	14.4	14.6

4.2.1.3 Probability of survival during transport or storage

Seed present in untreated products will survive transport and storage.

4.2.1.4 Probability of pest surviving existing pest management procedures

Risk management regulations in force and efficiency of regulations are listed in table 5. Partly due to this regulations the risk of entry are generally low. Only the bird seed pathway is rated as medium risk, since it represents a possibility for entry of lots of wild oats seed into Norway in spite of the risk management regulation.

4.2.2 Probability of establishment

4.2.2.1 Suitability of environment

Wild oats is established in large parts of the PRA area. Conditions in favour of cereals also favour wild oats due to their close relationship. Cereal production in the PRA area is limited by climate. The wild oats distribution is closely following the distribution of cereals (Figure 2). Wild oats competes well with cultured cereals. To some extent it occurs in roadsides and gardens in Norway. However, wild oats has no invasive potential outside managed land, due to its dependence of soil disturbance for germination and general growth conditions similar to growth of cereals.

4.2.2.2 Cultural practices and control measures

In important cereal growing areas the farmers control small infestation by systematically walking through the fields to detect the wild oats and eradicate it by hand roguing. In the 70's

and 80's control actions were often organized by the local agricultural authority to ensure that all cereal fields were inspected every year or every second year. In areas with widespread arable land and repeated cereal rotations the environment for spread is favourable. Also winter cereal cropping limits the wild oats, because only a small portion germinates in autumn and those which do will be killed during winter. Conditions in winter cereal for wild oats germination in spring are not good. High frequency of grass ley in the rotation is an important limiting environmental factor for wild oats establishment. This is especially important for organic farming.

4.2.2.3 Other characteristics of the pest affecting the probability of establishment

The wild oats seed dormancy protects the seed from germinating if it is spread during autumn.

4.2.3 Probability of spread after establishment

Wild oats seed is spread naturally only a few metres by the swaying action of the parent plant (Thill & Mallory-Smith 1997). Computer based weed-mapping of wild oats infestations has shown that patches remain relatively stable from year to year but expand 1-3 m on the leading edge in the direction of harvesting and cultivation (Wheeler et al. 2001). Without control, the wild oats population will increase annually, on the average, by a factor of three (Selman 1970).

The pathways identified in table 4 apply to both spread and entry but the probability of the pest being associated with the pathway at origin for spread (Table 7) is different from the probability of entry. In areas with widespread arable farming and repeated cereal monocultures, the environment for spread is favourable and spread from infested areas to non-infested areas is obvious. Under the current risk management regime for wild oats in Norway, the pathways for spread, detailed in table 7, is handled differently compared to entry (Table 5). Risk management procedures even vary among regions within the PRA area, based on the probabilities for wild oats being associated with the pathway at origin.

Similarly to the risk management measures for entry, the measures in force to prevent spread generate valuable data on the wild oats situation in the PRA area. Especially for the two pathways for spread, namely cereal seeds and whole oats for fodder, data are available (Table 8). The number of findings of wild oats infestations in the certified cereal seed production in Norway displays a quite stable level of infestation at about 40 infested seed production fields during the last years (Table 8 and Figure 5). The findings of wild oats in whole oats for fodder displays a higher variability, but the average level of infestation in samples seems to be around 5% (Table 8).

Table 7. Pathways for spread and assessment of the efficiency of regulations.

Pathway	Probability of the pest being associated with pathway at origin	Risk management regulations in force	Assessment of the efficiency of regulations
Cereal and grass seeds	High	Seed control and certified growing of seeds	Acceptable, this pathway is obvious but not possible to avoid (Table 8).
Whole grains, peas and seeds for feed	High	Generally prohibited. Dispensation in the counties Aust-Agder, Vest-Agder, Rogaland, Hordaland, Sogn og Fjordane, Møre og Romsdal, Nordland, Troms og Finnmark, given that the farm is free of wild oats. In the other counties, authorised mills can sell grain as feed, given that the product come from a farm without wild oats and that a sample of 1 kg per 10 tons is analysed and found free of wild oats.	In the mentioned counties, wild oats infestation is unlikely because cereals constitute a low portion of arable land, see figure 4. Dealers have to keep this feed oats lots separate from ordinary oats. According to Felleskjøpet ØstVest the cost of administration of these wild oats free cells is about NOK 35 per ton (see attachment 2). Rather few of the examined samples contain wild oats (Table 8) and hence the regulations are sufficient even without this examination.
Unthreshed grain, sheaves, straw, seedstraw, milling waste, chaff, manure, compost, soil and plants with soil	High	Sale or trade prohibited from areas with wild oats	Regulations is based on an up-dated wild oats database and are acceptable provided sufficient effort in maintaining the database
Combiner, straw press, other harvesting equipment and production machinery	Medium	Must be thoroughly cleaned for wild oats before moved or sold to other fields	The efficiency is high, but due to structure change with several farms within a business unit the possibilities to control is limited.
Untreated straw	Low	Must be covered during transport	The spread with this transport is probably limited, and the regulation can be left out.

Table 8. Findings of wild oats in Norway in the period 1999 – 2006 in two potential pathways for spread. Source: Kimen Såvarelaboratoriet AS, Norway.

	1999	2000	2001	2002	2003	2004	2005	2006
Findings of wild oats infestations in fields for cereal seed production	42	43	33	36	48	37	47	32
Area of cereal seed (1000 hectare)	17.1	16.7	16. 6	17.3	18.2	17.8	16.3	15.6
Findings of wild oats in samples of whole oats for horse fodder	4	0	5	5	5	8	2	2
Total number of samples of oats for horse fodder	83	70	69	68	64	73	51	57

Figure 5. New findings of wild oats infestations in certified Norwegian cereal seed production fields (solid line with circles) and the total area of cereal seed production (dotted line with squares) in recent years

When wild oats is found on fields where cereals for seed were grown the preceding year, it is likely that the seed lots are contaminated and that new infestations took place when the seed from that preceding year is sold and planted. When this occurs in practise the probability of spread with this pathway is quite high.

Historical data of the Norwegian certified cereal seed production document findings of wild oats in samples during the period 1982 – 1987 and during the period 2001-2006. Comparison of data from the first period with recent data (Figure 6) indicates that the number of findings is quite stable, even though the incidence of new infested farms was much higher in the period 1978-1987 compared to the period 1998-2007 (Figure 7 and 8).

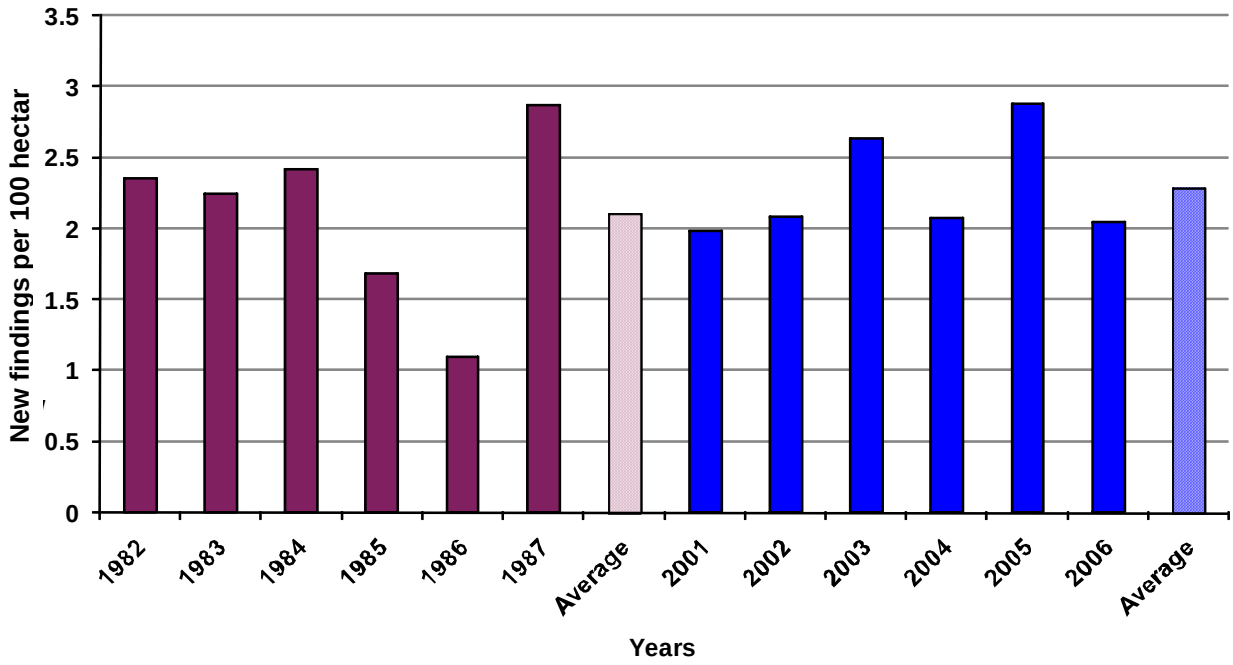

Figure 6. Frequency of findings of wild oats in contracted acreage of certified cereal seed production

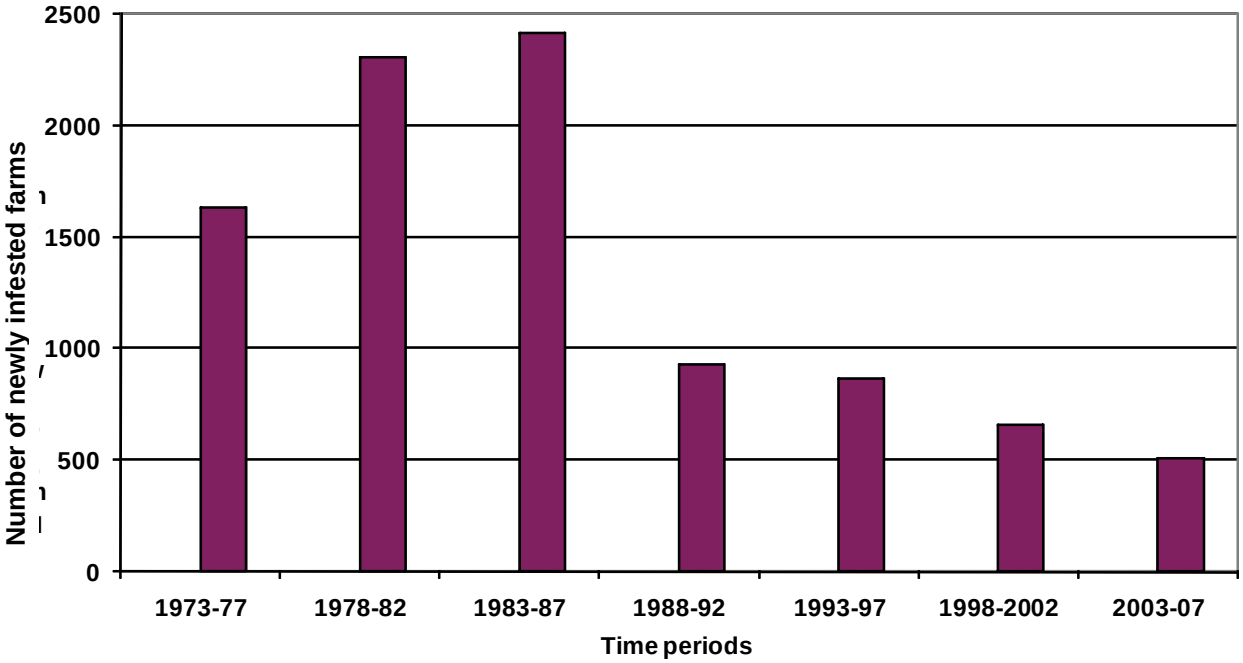

Figure 7. Total number of farms with new infestations each period.

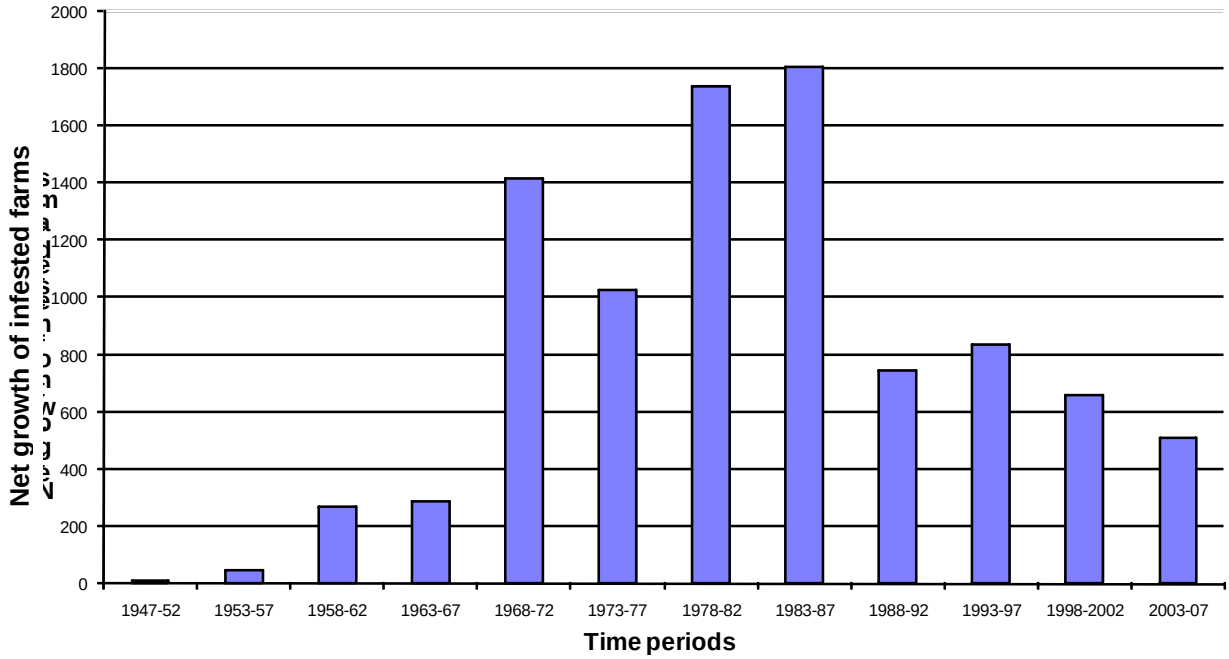

Figure 8. Net growth in number of farms infested with wild oats in Norway. Net growth is total number of farm with new infestation minus farms where the wild oats has been eradicated.

Regarding other pathways for spread, movement of wild oats infested soils is known to occur in relation to road construction. Although prohibited, it is likely to occur outside the agricultural sector due to lack of knowledge or awareness of wild oats and the associated regulations. Another pathway of spread is by animals and, in particular, by horses (e.g. by manure and soil brought by these). Traffic by horses on agricultural land is quite frequent.

4.2.4 The official wild oats register as a control measure for preventing spread

For several of the regulations the validity of the Norwegian wild oats register is important. It is therefore appropriate to question whether the register is a reliable tool. Figure 7 and 8 above demonstrate a dramatic fall in new infestations from the late 1980's. This low rate of infestation has lasted up to now. The question is whether this reflects that the spread of wild oats is actually lower or whether the reason is that less effort is made to discover new infestations. According to information in annual reports from The Norwegian Plant Protection Institute (Statens Plantevern/Planteforsk 1973-1996) there was a high activity in organized inspection of cereal field in the 70's and the 80's. According to information from the local agricultural authorities, organized inspections are much fewer today. During this pest risk assessment work we made a survey by asking for the opinion of responsible staff in 8 major agricultural municipalities in South-East Norway. Table 9 shows the opinion of responsible staff in 8 major agricultural municipalities in South-East Norway.

The most striking result from the interviews was the low activity in organised inspection of the fields. The officials spend on average only 10 days per year on registration and control of wild oats. Inspection rate depends now on the individual farmer and in average the officials thought that farmers did a fair job in this respect. The follow up on farms with serious infestations was very good, and probably this is a very important contribution to reduce spread and establishment locally. This contributes also to a more reliable wild oats register. Four of eight offices practiced warning with sanctions, and report good effect of this. The officials were also asked what in their opinion would be the most obvious reason for continued spread in their area. All of them mentioned first of all the increase in number of entrepreneurs in modern cereal framing. A consequence of this is that the same machinery and equipment are used on many farm to a higher extent than before, with a risk of bringing wild oats from one farm to another. Moreover, the entrepreneurs do not have time to inspect the fields for wild oats. In many cases each entrepreneur manages 300-500 hectares.

One reason for reduction in new entries to the wild oats register is the fact that in some regions a high portion of the farms are already registered (Figure 4) and hence spread to new farms is limited. As mentioned earlier effective follow-up controls by the authorities on heavily infested farms (as founded in the wild oats act) can contribute to less spread. Provided that focus on wild oats is maintained both by the farmers and central and local plant health authorities, the official register will continue to be a good tool for preventing spread.

Table 9. Opinions on activities on registration and control of wild oats in 8 major agricultural municipalities. The questions were addressed to official persons in charge of wild oats administration in the respective municipalities. Questions not answered are indicated with - - (Interviewer: Jan Netland October 2007).

Questions	**Scoring per unit**	**Average**
1. a. Has organised inspections for wild oats taken place since 2000? (0= No, 3= Only based on farmers inspection of own area, 5=Based on organised inspection)	0- 3- 0- 0- 3- 5- 0- 5	2
b. Number of years with organised inspections since 2000: (0=0, 3=between 1 and 4, 5=every year)	0- 5- 0- 0- 5- 3- 0- 3	2
c. Does the local agricultural authority register findings of wild oats on new farms? (0=No, 3= If findings are reported. 5=As part of own yearly activity)	3- 5- 0- 3- 5- 5- 3- 5	3.6
d. How often does the local agricultural authority follow *) up on farms with serious wild oats infestations? (0=Never, 5= Every year)	5-5-5-5-5-5-5-3	4.75
Approximately how many days work per year does the local agricultural authority spent on wild oats registration and control work?	25-7-5-5-14- -10-4	10
2. Do the farmers carry out wild oats inspection on their area? (1= Poor, 2= Fair, 3= To a satisfying extent)	2-2-3-3-2-3-2-3	2.5
3. Statistics show that there were almost 3 times more new farms with wild oats findings in the period 1973-87 compared to the period 1988-2007. What is your explanation to this?		
A. The spreading is actually less in the last than in the first period: (Scale 1 to 5 where 1= is true, 5=not true)	5-1-3-4-3-3-5-3	3.4
B. The organized inspection activity is reduced so new infestations are not recovered: (Scale 1 to 5 where 1= true, 5=not true)	1-1-3-4-5-1-3-3	2.6
4. How well is the wild oats database updated? (1= Poor, 2= Fair, 3= To a satisfying extent)	2-2-3-2-2-3-2-2	2.25
5. The wild oats database is less updated now than for 20 years ago. (Scale 1 to 5 where 1= true, 5=not true)	1-5-3-4-5-4-3- -	3.6

*) Follow up effort can be inspection to check if the wild oats has been controlled or if there are wild oats closer than 20 m from the neighbouring farm.

4.2.5 Conclusion on the probability of introduction and spread

The overall probability of introduction of wild oats to new farms in the PRA area of Norway is obviously, since it has been introduced for a long time. The probability of further spread is high.

4.2.5.1 Conclusion regarding endangered areas

The endangered area constitutes farms within the PRA area not yet infested. According to figure 4 the portion of not yet infested farms ranges from 32 to 100% of agricultural area on the county level. The total grain and oil seeds production area was 331905 hectares in 2005 of which 318271 hectares are wheat, barley and oats (Statistics Norway 2007a). Unfortunately, the Norwegian wild oats database only contains information about the total size of the infested farms. In order to estimate the proportion of arable land with wild oats, considerable effort has been invested in this pest risk assessment by linking information of infested farms with digital geographical information (see an example in attachment 3). No information on size or proportion of arable land on the infested properties is available in the wild oats database itself.

The agricultural area infested by wild oats is, therefore, estimated here based on the proportion of agricultural area to total area, available on municipality level (Statistics Norway 2007c). Table 3 shows that this yields 103028 hectares of wild oats infested agricultural land or 31% compared to the total area of growing of grain and oil seeds. Subtracting the estimate of agricultural land infested with wild oats from the total area of cereal and oilseed, yields 228858 hectares as a maximum estimate of total endangered area in Norway.

Looking at the general pattern of establishment and spread (Figure 2 and 4), it can be observed a lower frequency of infestation in the counties of Trøndelag (Figure 4) although some regions of Trøndelag has many farms with cereal monocropping. It is likely that this lower frequency of infestation is due to a later start of the spread than in South-East Norway, and less likely due to limitations in establishment potential. This is because no evidence indicates that other limits to establishment are acting, except the growing of cereals in the PRA area.

4.3. Assessment of potential economic consequences

4.3.1 Pest effects

4.3.1.1 Direct pest effects

Direct pest effect is yield loss with the current agricultural practice. Direct yield losses at different infestation levels are not measured in Norway. According to figure 3, 25 wild oats plants per m^2 reduced yield with 12% and 18% for barley and wheat, respectively. Yield loss of 32% has been reported in field trials in Norway (Haugsten 1993a). However, only very few fields have infestations of that magnitude and in case, they would have been treated with herbicide. Currently the actual yield loss due to wild oats is minor in Norway.

4.3.1.2 Indirect pest effects

Indirect pest effects are treatment cost and cost of preventive measures taken by authority as well as the farmers. The yearly acreage treated with wild oats herbicide from 1978-2007 is shown in figure 9. The data presented in the figure shows a marked increase in treated area

from 1998 to 2007 compared to the period 1978-97 (Mattilsynet 2008). The steep growth in herbicide used to control wild oats is the highest growth of all pesticide segments.

The herbicide cost and cost of spraying operation in 2006, and per year in the period 2003-2007, are shown in table 10. Cost of spraying operation is according to the norm of the Norwegian Agricultural Economics Research Institute (Refsgaard et al. 2006).

Control of small infestations by hand-roguing and inspection to discover new infestation both by farmers and agricultural authorities will add to the total cost for chemical control stipulated in table 10. Further in this document this part is referred to as additional work or additional costs.

There is also an environmental aspect associated with the use of chemical control as the main control measure for wild oats. The reason for this is that chemical control is the most cost effective control measure.

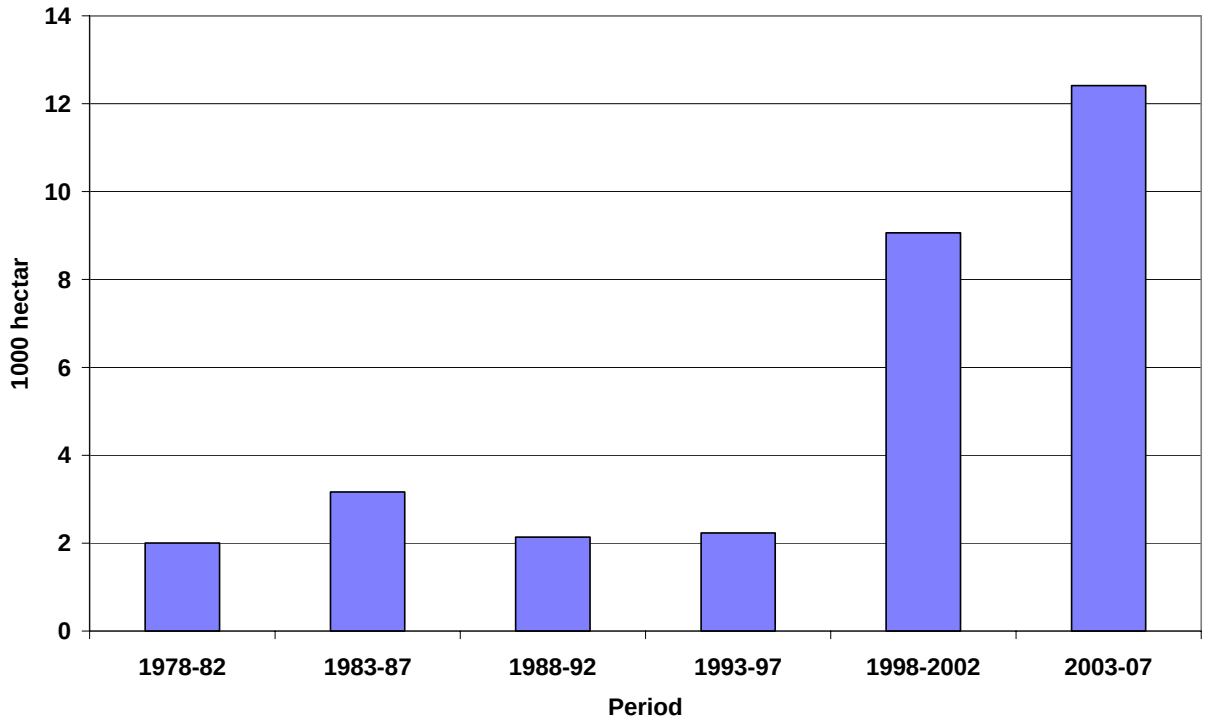

Figure 9. Area treated with wild oats herbicides as average over 5 years in the period 1978 to 2007.

Table 10. Actual herbicide treatment costs in NOK for the year 2006 and the annual average for the last five years 2003-2007. For 2006 the herbicide costs are provided per hectare as well.

Cost source	2006 total	2006 per hectare	Average total during 2003-2007
Herbicide	6960000	418	4965800
Spraying operation	3000000	180	2233720
Total cost	9960000	598	7199520

4.3.2 Analysis of economic consequences

All the economic consequences are due to indirect effect of the pest. In 1993 Jon Harald Haugsten calculated total cost of wild oats in Norway to NOK 5-7 mill per year, including official control, weeding and spraying against wild oats performed by farmers, as well as expenses for fine grinding of forage grain aiming at destroying eventually occurring grains of wild oats (Haugsten 1993a). The cost of herbicide treatment of 2000 ha (Figure 9) amounted at that time to approximately NOK 0.8 mill. NOK 6.2 mill was the highest estimate for additional work in 1993. This amount equals to 8.1 mill in 2006 according to Statistics Norway (2007b). The total cost (herbicide treatment + additional work) is thus stipulated to approximately NOK 15 mill per year in the period 2003-07. This amount does not include administrative and regulatory work at Mattilsynet

It is very difficult to estimate economic consequences of environmental aspects (Refsgaard et al. 2006). Hence the environmental aspects of herbicide use have to be a qualitative character.

4.3.2.1 Scenarios on economic consequences

Scenario 1: Treatment of all currently infested area.

Currently infested area (103028 ha) means total arable land of all farms registered in the wild oats distribution database presented in table 3. If the development continues according to the last two increments shown in figure 9, one scenario is that all these areas have to be treated with herbicide and the cost will be:

Total cost: 103028 ha x NOK 598 per ha = NOK 61.6 mill + NOK 8.1 mill (additional cost) = approximately NOK 70 mill.

Assumption: The number of 103028 hectares of wild oats infested land is estimated from total size of infested properties (from the Norwegian wild oats database) adjusted by proportion of agricultural area in the municipality and then summarised for the country.

Cost of chemical treatment (NOK 598 per ha) is calculated in table 10.

In this scenario additional cost to prevent spread is unchanged compared to the current situation: NOK 8.1 mill.

Scenario 2: Wild oats has the potential to establish on all fields with continuous cereal monocropping.

The total area of cereals in Norway is 331905 ha. Treatment cost will be: 331905 ha x 598 = approximately 200 mill NOK per year

Assumptions: In this scenario additional cost to prevent spread is left out because there is no possibility for further spread. The total area of cereals in Norway is taken from section 4.2.5.1 on endangered areas.

4.3.3 Conclusion of the assessment of economic consequences

The cost of chemical control of wild oats has increased considerably since the end of the 1990's. The increase is probably connected with the structural changes in cereal cropping, with a still increasing number of entrepreneurs in modern cereal framing. In each of the years 2006-07 the herbicide treated area amounted to 16600 ha. There is a large endangered area in Norway. Thus, the control of the wild oats with herbicides is most likely to take place on an even larger area than today. This will increase the costs of controlling the weed.

4.4. Degree of uncertainty

The processes of entry, establishment and spread are all reasonably well known for the pest in relation to the PRA area. The frequencies of entry along the pathways, for which data are available (Table 6 and 8; Figure 5 and 6), indicate a stable level of infestation with little variability. These elements of this pest risk assessment are considered to have low uncertainty.

The direct economic consequences have low uncertainty. The areas with heavy infestation causing yield losses are small. Heavy infestations would be effectively controlled and yield loss would hence be minimised. With more organic farming there can be more uncertainty because control of heavy infestations will be more expensive than in conventional farming.

The indirect economic consequences have a moderate level of uncertainty. The cost of chemical treatment per ha is easy to calculate. The treated area is increasing and it is not easy to predict when the increase will level out. One scenario is that the total infested area will be treated with herbicide. Another scenario is that the wild oats will spread into the endangered area. If these new infestations are not discovered when they are still at a low level, a considerable increase in herbicide treated area could be expected. This is closely connected to the level of activity in organised and/or the farmers own inspection of the fields. This brings us back to the reliability of the wild oats database

This pest risk assessment includes an evaluation of the wild oats database. Evaluation of the database shows an increasing level of uncertainty in the database during the last years from a low to a moderate level. Uncertainty in the wild oats database constitutes the main source of uncertainty in this pest risk assessment.

5. CONCLUSION

Wild oats (*A. fatua*) is present in 155 out of 431 Norwegian municipalities. It is widely distributed in all municipalities in the main agricultural areas in south-east and central-east Norway, and in the municipalities close to the Trondheim fjord. Otherwise wild oats is present in only a few scattered municipalities not geographically connected to these main areas.

Endangered area, not yet infested by *A. fatua*, is estimated to 228858 ha. This area is spread over the cereal growing part of Norway. The counties of North- and South -Trøndelag have a higher portion of endangered area not yet infested than south and central part of East Norway.

The probability of entry of *A. fatua* from outside the PRA area (Norway) is very low.

The probability of spread within Norway is high. In areas with low infestation, like in Trøndelag, the probability of spread is lower than in heavily infested areas. However, in areas with high level of infestation there are few new farms left to be infested.

The official wild oats register is a valuable tool in regulations aiming to limit spread. The register also provides a tool to follow up infested farms. The register would be even more useful if inspection for infestation on new farms had been more systematic.

Wild oats is no longer devastating even in cereal monocropping, due to cost efficient herbicides. However, in Norway an increasing area is infested with wild oats. The infestation may vary from only a few plants to total coverage of the field.

In cereal monocropping chemical treatment with and without hand roguing is the only feasible control methods. Hand roguing alone is expensive and ineffective even on modest infestation.

The structural changes in cereal farming result in more farms being managed by entrepreneurs. Field managed by entrepreneurs promotes use of herbicide even on small infestations since this is a cost effective measure to control the weed. Less official control of cereal fields can also be expected. The economical consequences are thus expected to be high. The economical consequences can be even higher in organic farming if the most profitable rotation has to be changed to a less profitable one because of wild oats infestation.

6. REFERENCES

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ATTACHMENT 1

FOR 1988-03-25 nr 251: Forskrift om floghavre:

Fastsatt ved kgl.res. 25. mars 1988 med hjemmel i lov av 19. desember 2003 nr. 124 om matproduksjon og mattrygghet mv. (matloven) § 33 første ledd, jf. § 36 andre ledd, jf. delegeringsvedtak av 19. desember 2003 nr. 1790. Fremmet av Landbruksdepartementet. Endret 25. september 1990 nr. 770, 6 feb 2001 nr. 117, 9 jan 2004 nr. 157 (bl.a hjemmel).

§ 1. Eier eller bruker av fast eiendom, herunder private, kommuner og staten som har kjennskap til at det finnes floghavre på eiendom, veiskråning og lignende, har plikt til å bekjempe floghavren effektivt.

Eier eller bruker av fast eiendom der det kan forekomme floghavre, skal foreta årlig floghavrekontroll på arealene. Til slike arealer regnes alt kornareal inneværende år, samt alt areal der korndyrking har foregått de siste 5 år.

Enhver som håndterer produkter eller varer som kan innholde floghavre, har plikt til å ta de forholdsregler som er nødvendig for at floghavre ikke spres.

§ 2. Eier eller bruker av fast eiendom som har kjennskap til eller mistanke om at det finnes floghavre på eiendommen, har plikt til straks å melde fra til kommunal landbruksforvaltning, som igjen melder fra til Fylkesmannens landbruksavdeling og Mattilsynet. Meldingen skal være ledsaget av planteprøve. Dersom Mattilsynet bekrefter at det er floghavre, kan eier eller bruker forlange offentlig inspeksjon for å fastslå omfanget av forekomsten og vurdere andre forhold av interesse for bekjempelsen. Mattilsynet, Fylkesmannens landbruksavdeling og kommunal landbruksforvaltning skal gi veiledning om rådgjerder og tiltak for å bli kvitt dette ugraset.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 3. Ved omsetning, bortforpakting eller bortleie av fast eiendom plikter overdrageren å si fra til den annen part hvis det forekommer floghavre på eiendommen. Forpakter/leier plikter også å opplyse om han/hun driver andre eiendommer der det forekommer floghavre. Den samme opplysningsplikt gjelder ved jordskifte.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 4. I tillegg til effektiv floghavrebekjempelse på hele arealet, har eier eller bruker av fast eiendom hvor det er floghavre, i hele vekstsesongen særlig plikt til å holde et 20 m bredt belte mot åpne kanaler, elver, bekker, veier og dyrka mark på naboeiendom fritt for frøbærende floghavreplanter. Det samme gjelder arealer som årlig er utsatt for flom. Bortluket floghavre skal brennes.

§ 5. Når eier eller bruker av fast eiendom hvor det er påvist floghavre, mener å ha utryddet denne, kan han først den påfølgende vekstsesong forlange offentlig inspeksjon. Dersom det ved offentlig inspeksjon i to vekstsesonger på rad ikke blir funnet floghavre, skal Mattilsynet gi skriftlig erklæring om dette. Slik erklæring kan bare gis dersom hele driftsenheten er fri.

Forbud og pålegg som gjelder eiendom hvor det er påvist floghavre, faller dermed bort.

Det må i kontrollårene dyrkes en lett kontrollerbar vekst (bygg eller vårhvete) på det skiftet der floghavren er funnet.

Åkeren må ikke ha mer lengde enn at kontrollen kan utføres tilfredsstillende.

Mattilsynet kan i særlige tilfelle fravike kravet om kontrollerbar vekst.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 6. Det er forbudt for brukere av eiendom med floghavre å omsette eller på annen måte avhende korn, oljefrø og erter til modning til firmaer/bedrifter som i sin videre behandling av varen ikke bruker metoder som klart ødelegger spireevnen hos floghavrefrø. Det er selgerens ansvar så langt som mulig å forvisse seg om at kjøper tilfredsstiller dette krav.

Frø av storfrøede grasarter (engsvingel, raigras, bladfaks og strandrør) fra areal der det ved vekstkontroll er funnet floghavre, kan bare omsettes etter særskilt tillatelse fra Mattilsynet.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 7. Det er forbudt for eier eller bruker av eiendom, hvor det er floghavre eller mistanke om dette, å omsette eller på annen måte avhende lo, julenek, halm, frøhalm, kornavrens, frøavrens, agner, husdyrgjødsel, kompost, jord og planter med jord.

Fra eiendom med floghavre er det tillatt å avhende halm og frøhalm som er forskriftsmessig behandlet, slik at spireevnen er ødelagt. Behandlingen skal utføres på den eiendom der dyrkingen har skjedd.

Levering av halm til felles lutingsanlegg med forskriftsmessig luting regnes i denne forbindelse ikke som avhending, men transporten må foregå i samsvar med § 10 i denne forskrift.

Enhver som presser halm på andres eiendom skal ta kontakt med jordbruksetaten i kommunen/fylket for å innhente informasjon om eiendommens floghavresituasjon.

Halm eller frøhalm som skal nyttes som dekkhalm på eller ved dyrket jord, må stamme fra arealer som har hatt offentlig kontroll med floghavre i veksttiden.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 8. Omsetning eller annen avhendelse av helt korn, erter og frø til fôr er forbudt. Det korn, erter og frø, både norskavlet og importert, som skal brukes til fôr, skal før det blir levert til detaljist, innkjøpslag eller forbruker, være så fint malt, eller på annen måte behandlet, at spireevnen i eventuell floghavre er ødelagt. Bestemmelsen gjelder også blandinger, herunder alle former for kraftfôrblandinger og dessuten avrens og avfall av korn, erter og frø som skal brukes til fôr. Bestemmelsen gjelder også bytte- og leiemaling.

Halm, kornnek e.l., som innføres til landet, skal være fulgt av en attestasjon fra eksportlandets planteinspeksjonstjeneste som attesterer at bruket hvor halmen/kornneket stammer fra skal være kontrollert av offentlig tjenestemann i siste vekstsesong og funnet fri for floghavre.

Importørene er selv ansvarlig for at slik attestasjon følger sendingen.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 8a. Forbudet i § 8 første ledd første punktum gjelder ikke for omsetning av fôr til fugler som ikke er av økonomisk betydning som husdyr forutsatt at vilkårene i a) - f) er oppfylt.

a) Det skal bare nyttes korn og frø som er antatt fritt for floghavre.

b) Salg eller annen avhendelse av spiredyktige frø av planter som inneholder narkotiske stoffer er forbudt.

c) Import kan kun foretas på grunnlag av offisielt analysesertifikat utstedt av Mattilsynet. Analysen som legges til grunn for analysesertifikatet skal være utført ved laboratorium godkjent av Mattilsynet. Analysen må vise at prøven er fri for floghavre. Prøven skal være en gjennomsnittsprøve.

d) For korn og frø som er større enn korn av hvete, skal prøven utgjøre 1,0 kg pr. 25 tonn vare. For partier mindre enn 25 tonn skal prøven være på 1,0 kg. For frø som er mindre enn korn av hvete, skal prøven være på 0,5 kg pr. 10 tonn. For partier mindre enn 10 tonn skal prøven være på 0,5 kg.

e) For korn og frø som importeres i standardpakninger, beregnet på direkte salg til forbruker, skal det prøvetas etter samme vektforhold som under bokstav d. Minste prøvestørrelse skal være en pakning.

f) Unntatt fra prøveplikt er frø som importeres i hele aks eller kolber, og frø som importeres i støpt eller presset form som «tranbjeller», «frøklokker» eller liknende.

0 Tilføyd ved forskrift 9 jan 2004 nr. 157.

§ 9. Det er forbudt, unntatt til undervisning og vitenskapelige formål, å importere, omsette eller på annen måte avhende planter, plantedeler og frø som kan defineres som floghavre.

Forbudet gjelder også når floghavre eller floghavrefrø utgjør en del av eller finnes i annen vare f.eks. i plantedekorasjoner, ikke rengjorte maskiner e.l.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 10. Når korn, erter, frø, frøavrens og avfall av korn, erter og frø transporteres løst (uten emballasje) med bil, traktortilhenger eller lignende, skal bunnen være tett, og lasset være tildekket så vel over som på sidene, slik at spill ikke kan forekomme. Det samme gjelder ved transport av halm eller frøhalm som ikke er forskriftsmessig behandlet (jfr. § 7).

Innenfor samme driftsenhet gjelder bestemmelsen i denne paragraf bare når transporten foregår langs eller over annen driftsenhet.

§ 11. Skurtreskere, andre høstemaskiner, halmpresser og anleggsmaskiner skal alltid være grundig rengjort for floghavre før de flyttes til annen jordbrukseiendom eller omsettes.

All emballasje som har vært nyttet til korn, erter, frø, frøavrens og avfall av korn, erter og frø, skal være grundig rengjort, slik at mulig floghavre er fjernet før den tas i bruk på nytt. Det er forbudt å omsette eller på annen måte avhende brukte sekker som ikke er grundig rengjort og fri for floghavre.

Transportmidler som har vært nyttet til transport av korn, erter, frø, avrens og avfall av korn, erter og frø, skal rengjøres grundig etter bruk, slik at mulig floghavre blir fjernet. Det samme gjelder for transportmidler som har vært nyttet til transport av produkter omhandlet i § 7 fra eiendommer hvor det er floghavre.

Lagerrom og tørker som har vært brukt til floghavrebefengt korn, erter og frø, skal være grundig rengjort før behandling av ny vare, som ved videre omsetning eller bruk kan medføre fare for spredning av floghavre.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 12. All såvare av korn, erter, oljefrø og storfrøede grasarter som omsettes eller på annen måte avhendes, skal ordinært være underkastet offentlig kontroll i veksttiden.

Hvis behovet for såvare av nevnte arter enkelte år ikke blir dekket med vekstkontrollert vare, kan Mattilsynet gi tillatelse til å omsette såvare som ikke er kontrollert i veksttiden. Slik vare skal da underkastes en mer omfattende laboratoriekontroll (dobbelt prøvestørrelse), og det må gå klart fram av merkingen at varen ikke er vekstkontrollert.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 13. Ved leierensing av såvare av korn, erter, oljefrø og storfrøede gras- arter, skal maskiner og annet utstyr alltid rengjøres, slik at eventuell floghavre er fjernet før arbeidet med vare fra annen produsent påbegynnes.

§ 14. For avrens og avfall fra korn, erter og frø som skal nyttes til fôr, gjelder bestemmelser i § 8.

Annen avrens og avfall av korn, erter og frø fra siloer, møller, bryggerier, brennerier, såvareforretninger og leierenserier, skal fortrinnsvis brennes eller behandles på en slik måte at spireevnen i mulig floghavre blir ødelagt. Henlegging av vare på fylling eller tilsvarende kan gjøres på betingelse av at henleggingssted og behandlingsmåte er godkjent av Mattilsynet. Transporten skal skje i samsvar med § 10 i disse forskrifter.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 15. Mattilsynet kan i særlige tilfeller dispensere fra bestemmelsene i denne forskriften, forutsatt at det ikke vil stride mot Norges internasjonale forpliktelser, herunder EØS-avtalen.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 16. Mattilsynet fører tilsyn og fatter vedtak for å gjennomføre bestemmelsene gitt i eller i medhold av denne forskriften. Tilsynet med overholdelse av floghavrebestemmelsene påhviler i tillegg Fylkesmannens landbruksavdeling, kommunal landbruksforvaltning og Tollvesenet.

Mattilsynet gis myndighet til å avgjøre om det er påvist floghavre.

Tilsynsmyndighetene har uhindret adgang til eiendom, bygninger, lagerrom, utsalg og utstyr, hvor tilsyn er nødvendig for en effektiv kontroll. De har rett til uten vederlag å ta prøver til undersøkelse.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 17. Hver høst skal Mattilsynet, på grunnlag av den løpende registrering, utarbeide fylkesvise register over eiendommer hvor det er påvist floghavre. Av hensyn til de spesielle bestemmelser som gjelder for slike eiendommer, skal registeret være offentlig.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 18. Omkostninger eller tap som påføres eier eller bruker av fast eiendom ved bekjempelse av floghavre etter gjeldende lov om floghavre og forskrifter gitt i medhold av den, blir som regel å bære av vedkommende eier eller bruker. I særlige tilfelle, hvor det vil virke åpenbart urimelig eller særlig tyngende for vedkommende å bære omkostningene eller tapet selv, kan refusjon eller vederlag, helt eller delvis, bli gitt etter avgjørelse av Mattilsynet. Vederlag kan ikke gis hvis skadelidte ved egen skyld har forårsaket utgiftene eller skaden.

Refusjon etter første ledd går tapt hvis det ikke er fremmet søknad for Mattilsynet innen seks måneder etter at utlegget, arbeidet eller skaden har funnet sted.

Unnlater eieren eller brukeren å etterkomme påbud gitt i medhold av denne lov, kan departementet eller den dette bemyndiger, etter særskilt varsel, la arbeidet bli utført for hans regning og la utgiftene bli inndrevet ved utpanting.

0 Endret ved forskrifter 6 feb 2001 nr. 117, 9 jan 2004 nr. 157.

§ 19. Forsettlig eller uaktsom overtredelse av denne forskriften eller vedtak gitt i medhold av den, er straffbar i henhold til matloven § 28.

0 Endret ved forskrift 9 jan 2004 nr. 157.

§ 20. Denne forskrift trer i kraft 1. mai 1988. Samtidig oppheves forskrifter av 7. februar 1975 om floghavre.

0 Endret ved forskrift 9 jan 2004 nr. 157 (tidligere § 21).

ATTACHMENT 2

Forespørsel til Felleskjøpet ØstVest ved kornsjef Øyvind Juel

Hei,

Jeg viser til telefonsamtale. Som nevnt holder vi på med en rapport om floghavre etter oppdrag fra Vitenskapskomiteen for Mattrygghet.

Omsetningen av hel havre til hest er regulert i forskriftens §8:

§ 8. Omsetning eller annen avhendelse av helt korn, erter og frø til fôr er forbudt. Det korn, erter og frø, både norskavlet og importert, som skal brukes til fôr, skal før det blir levert til detaljist, innkjøpslag eller forbruker, være så fint malt, eller på annen måte behandlet, at spireevnen i eventuell floghavre er ødelagt. Bestemmelsen gjelder også blandinger, herunder alle former for kraftfôrblandinger og dessuten avrens og avfall av korn, erter og frø som skal brukes til fôr. Bestemmelsen gjelder også bytte- og leiemaling.

0 Endret ved forskrift 9 jan 2004 nr. 157.

All omsetning av hel havre til hest er basert på dispensasjon fra denne forskriften. Dispensasjon blir gitt dersom havrepartiene er tatt fra gårder der det ikke er registrert floghavre i følge det offisielle floghavreregisteret (administrert av Mattilsynet), det ikke er funn av floghavre i innsendt analyseprøve på 1kg per 25 tonn og at partiene blir holdt avskilt fra ordinære havreparti på de ulike kornsiloene.

Mitt spørsmål er hva det koster Felleskjøpet å administrere disse tiltakene f. eks per tonn omsatt havre. Jeg forventer ikke en detaljert oppgave, bare et anslag. Dersom merkostnadene ved å tilfredsstille floghavreforskriftene er marginale, er det også en viktig å få fram. Uansett er det fint om dere setter opp hvilke tiltak som blir satt i verk av FK for å oppfylle kravet i dispensasjonen.

Dersom noe er uklart så ta kontakt.

På forhånd takk!

Vennlig hilsen

Jan Netland

Leder Seksjon ugras

Bioforsk Plantehelse

Telf.: 97178710

Svar fra FK
Hei.

Jeg har fått kopi av en mail du har sendt og skal prøve å gi et svar. Dette er vanskelig å anslå økonomisk og du må derfor ha det i tankene når du går videre med saken. Fremfor alt er vi i vår organisasjon opptatt av å hindre videre spredning av floghavre, og gjerne bidra positivt til at allerede registrerte gårdbruk kan erklæres fri for dette ugraset.

For å få fram hel og knust havre til hest har vi av ulike grunner basert oss på kontraktsdyrking av kvalitetshavre. Det grunnleggende her er at gården skal være floghavrefri, og videre har vi med andre kriterier for at havren skal kvalifiseres som kvalitetshavre. I tillegg til denne kontraktsdyrkingen utsorterer enkelte av våre kornmottak fin havre fra gårdbruk som ikke finnes i floghavreregisteret.

Vi anslår en kostnad på omlag 30-35 kr. pr. tonn omsatt vare for generell administrasjon, kontrakter, vilkår og ajourhold. I anslaget inngår også analysekostnader og utsorteringsgodtgjørelse.

Samlet omsetning i Felleskjøpet Agri ligger årlig på omlag 2 500 tonn hel og knust havre til hest.

Vennlig hilsen
Felleskjøpet Agri

Aslak Hauge
Fagsjef korn
Telf. 22861059

ATTACHMENT 3

An example of information of infested farms (red areas) with digital geographical information to estimate the proportion of arable land with wild oats is shown below.