Vitenskapskomiteen for mattrygghet
Norwegian Scientific Committee for Food Safety

VKM Report 2016: 23

Risk Assessment of cockspur grass (*Echinochloa crus-galli*)

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

Report from the Norwegian Scientific Committee for Food Safety (VKM) 2016: 23
Risk assessment of cockspur grass (*Echinochloa crus-galli*)

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31.05.2016

ISBN: 978-82-8259-213-0
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Suggested citation: VKM. (2016). Risk assessment of cockspur grass (*Echinochloa crus-galli*). Scientific Opinion of the Panel on Plant Health of the Norwegian Scientific Committee for Food Safety, ISBN: 978-82-8259-213-0, Oslo, Norway.

Risk assessment of cockspur grass (*Echinochloa crus-galli*)

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Assessed and approved

Acknowledgment

The Norwegian Scientific Committee for Food Safety (Vitenskapskomiteen for mattrygghet, VKM) has appointed a working group consisting of both VKM members and an external expert to answer the request from the Norwegian Food Safety Authority. Project leader from the VKM secretariat has been Elin Thingnæs Lid. The members of the working group, Guro Brodal and Trond Rafoss (Panel on Plant Health) and Jan Netland (NIBIO) are acknowledged for their valuable work on this opinion. The Panel on Plant Health are acknowledged for comments and views on this opinion. Åshild Ergon, member of the Panel on Plant Health, is acknowledged for preparing and chairing the discussion in the panel. VKM would like to thank Kimen Seed Laboratory, Felleskjøpet Agri, Strand Unikorn, the Norwegian Agricultural Extension Service (Norsk Landbruksrådgiving) Viken, the Norwegian Food Safety Authority (Mattilsynet) and the Norwegian Agricultural Agency (Landbruksdirektoratet) for their contribution to data and other information as described in section 1.2.3. VKM would like to thank the County Governors (Fylkesmannen) of Vestfold and Østfold counties, and the municipalities of Larvik and Fredrikstad for data and information from 2015 on occurrence of *E. crus-galli* in the two counties.The County Governor of Buskerud, and the Norwegian Agricultural Extension Service units of Rogaland, Agder, Øst, Solør-Odal, Hedmark, Oppland, Sør-Trøndelag, and Nord-Trøndelag are acknowledged for their information about the status of *E. crus-galli* infestation in their regions of Norway. VKM would like to thank the hearing experts Jukka Salonen (Natural Resources Institute, Finland), Lars Andersson (Swedish University of Agricultural Sciences), and Peter Hartvig (Århus University, Denmark) for their information regarding spread and severity of *E. crus-galli infestations* in Finland, Sweden and Denmark, respectively.

Competence of VKM experts

Persons working for VKM, either as appointed members of the Committee or as external experts, do this by virtue of their scientific expertise, not as representatives for their employers or third party interests. The Civil Services Act instructions on legal competence apply for all work prepared by VKM.

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Summary

Since the 1980-ies, cockspur grass (*Echinochloa crus-galli*), also called barnyard grass, has become a problem weed on arable land in some areas in Norway, particularly in the counties of Vestfold and Østfold. Cockspur grass has characteristics which make it competitive and hard to control effectively and is considered to be one of the worst weeds world-wide.

The Norwegian Scientific Committee for Food Safety (VKM) has been asked by the Norwegian Food Safety Authority to 1) summarise current knowledge on the occurrence of cockspur grass in Norwegian agriculture, 2) identify pathways for entry and pathways for spread of the weed, 3) assess the potential of further spread and establishment of the weed in Norwegian agriculture, and to 4) assess the potential of harmful effect to Norwegian agriculture. In addition, an identification and evaluation of the effectiveness of risk-reduction measures has been requested. A risk assessment is needed by the Norwegian Food Safety Authority in order to consider whether measures should be implemented. Information about risk reducing measures will also be of interest to farmers.

VKM has appointed a working group consisting of two members of the Panel on Plant Health, one external expert and the VKM secretariat to answer the request. The Panel on Plant Health has reviewed and revised the draft prepared by the working group and finally approved the risk assessment of cockspur grass in Norway.

The core distribution areas for cockspur grass in Norway are the two counties Vestfold and Østfold. In addition to severe infestations in Larvik and Fredrikstad, the weed is also confirmed to be established in the municipalities of Lardal, Sandefjord and Stokke in Vestfold County, in Rygge, Sarpsborg and Halden municipalities in Østfold County, and in the municipalities of Øvre Eiker, Nedre Eiker, Kongsberg and Modum in Buskerud County. Over all, this area can be regarded as a more or less continuously infested area. The occurrence of cockspur grass also shows signs of spread beyond this area, and establishment of the weed north of the 60 degrees latitude is confirmed.

Cockspur grass was first registered in Norway in 1878, and was rare until 1970. Imported vegetable seeds, especially carrot, were the main pathway for cockspur grass to agricultural land in the 70-ties and 80-ties. Today, there are three pathways identified as relevant for entry of cockspur grass into Norway. Ranked by their relative importance, these are bird seeds, ornamental plants rooted in soil, and grass and legume seeds for planting. Four pathways are identified as relevant for spread of cockspur grass within Norway. Ranked by their relative importance, these are relocation of soil, machinery, seeds for planting, and seeds from places for feeding birds.

The probability of entry of cockspur grass from countries outside of Norway is considered as moderately likely, with a medium level of uncertainty. The overall assessment behind this conclusion is that the weed is frequently associated with pathways for entry (especially bird

seeds), the weed survives during transport and storage, and it is not affected by existing pest management procedures applied to consignments that might contain cockspur grass.

Cockspur grass is established in parts of Norway. The probability of further spread of cockspur grass within Norway is considered as likely, with a low uncertainty. The overall assessment behind this conclusion is that the weed has some non-specific pathways for spread (e.g. relocation of soil), no effective barriers to spread exist, and suitable crops/habitats are widely present in some parts of the country. Climate change may enhance the progress of northward spread.

The most important pathways for entry, bird seeds, is not likely to reach agricultural land directly, but depends on spread from places for feeding birds, possibly via infestations of waste deposits. When it comes to pathways for spread, both relocation of soil and machinery, the two most important pathways, and also seeds for planting, can spread the weed directly to agricultural fields. Therefore, spread within the PRA area might be more likely than establishment from new entries of *E. crus-galli*.

Cockspur grass is a summer annual plant, and it is hence dependent on arable cropping to survive. Therefore, and due to the fact that cockspur grass populations have been able to establish from Aust-Agder County in south to Hedmark County in north, all arable land in low altitudes of South Eastern Norway is considered as endangered area. The total area currently infested is roughly estimated to represent less than half of the endangered area. The economic consequences of cockspur grass-infestation of crops are assessed to be major in cereals and potato, and massive in vegetable. The overall assessment behind this conclusion is that in *E. crus-galli*-infested cereal or potato crops the yield is frequently significantly reduced and additional control measures are frequently necessary, whereas in *E. crus-galli*-infested vegetable crops, crop production is always or almost always reduced to a very significant extent and additional control measures are always necessary. The uncertainty behind this assessment is high due to insufficient documentation of the harmful effects.

Key words: VKM, risk assessment, Norwegian Scientific Committee for Food Safety, weed, barnyard grass, cockspur grass, *Echinochloa crus-galli*, entry, establishment, introduction, spread, pathway, endangered area, economic consequences, risk reduction options, weed management

Sammendrag på norsk

Siden 1980-tallet har arten hønsehirse (*Echinochloa crus-galli*) blitt et problemugras i åpen åker i enkelte områder i Norge, særlig i Vestfold og Østfold. Hønsehirse har egenskaper som gjør den konkurransedyktig og vanskelig å bekjempe effektivt. På verdensbasis er hønsehirse ansett som et av de verste ugrasene.

Vitenskapskomiteen for mattrygghet (VKM) fikk våren 2015 i oppdrag fra Mattilsynet å 1) oppsummere dagens kunnskap om utbredelse av arten i jordbruket i Norge, 2) identifisere innførselsveier og spredningsveier, 3) vurdere potensialet for videre spredning og etablering av arten i jordbruket i Norge, 4) vurdere skadepotensialet i jordbruket i Norge, og 5) identifisere og vurdere mulige effektive tiltak for å forhindre videre spredning og etablering eller redusere skade i jordbruket i Norge. Mattilsynet vil bruke risikovurderingen i sin vurdering av om eventuelle tiltak skal iverksettes. Informasjon om risikoreduserende tiltak vil også være av interesse for næringen.

VKM utnevnte en prosjektgruppe bestående av to medlemmer av VKMs faggruppe for plantehelse, en ekstern ekspert og VKMs sekretariat til å besvare oppdraget. Faggruppen for plantehelse har gjennomgått og revidert utkastet fra prosjektgruppen og godkjent den endelige rapporten.

Hovedområdet for utbredelsen av hønsehirse i Norge er Vestfold og Østfold fylke. I tillegg til store forekomster i Larvik og Fredrikstad, er etablerte forekomster av ugraset også bekreftet i kommunene Lardal, Sandefjord og Stokke i Vestfold, i kommunene Rygge, Sarpsborg og Halden i Østfold, og i kommunene Øvre Eiker, Nedre Eiker, Kongsberg og Modum i Buskerud. Alt i alt kan dette anses som et område med en mer eller mindre kontinuerlig forekomst. Utbredelsen av hønsehirse viser også tegn til spredning utover dette området, og etablering nord for 60. breddegrad har blitt bekreftet.

Hønsehirse ble første gang registrert i Norge i 1878, men var sjelden fram til 1970. Importerte grønnsaksfrø, spesielt gulrot, var den viktigste innførselsveien til jordbruket på 70- og 80-tallet. I dag er det tre innførselsveier som anses som aktuelle. Disse er, rangert etter deres relative betydning, importert fuglefrø, importerte prydplanter med jord, og importert såfrø av gras og belgvekster. Fire spredningsveier innenfor Norge anses som aktuelle. Disse er, rangert etter deres relative betydning, flytting av jord, jordbruks- og anleggsmaskiner, såvarer og frø fra foringsplasser for fugler.

Innførsel av hønsehirse fra land utenfor Norge anses som middels sannsynlig, med en moderat grad av usikkerhet. Den samlede vurderingen bak denne konklusjonen er at ugraset ofte forekommer i identifiserte innførselsveier (spesielt fuglefrø), ugraset overlever transport og lagring av forsendelsen, og det påvirkes ikke av eksisterende fytosanitære tiltak i forsendelser som kan inneholde ugrasarten.

Hønsehirse er etablert i deler av Norge. Videre spredning av ugraset anses som sannsynlig, med en lav grad av usikkerhet. Den samlede vurderingen bak denne konklusjonen er at ugraset har noen ikke-spesifikke spredningsveier (f.eks. flytting av jord), ingen effektive barrierer mot spredning forekommer, og passende kulturer/habitater er vidt utbredt i noen deler av landet. Klimaendringer kan fremme videre spredning av ugraset nordover.

Importert fuglefrø, som er den viktigste innførselsveien for hønsehirse, vil antakelig ikke ankomme jordbruksland direkte, men heller spres fra fuglefôringsplasser, muligens via forekomster av ugraset på avfallsplasser. Når det gjelder spredningsveier, så kan både flytting av jord, jordbruks- og anleggsmaskiner og såvarer spre ugraset direkte til jordbruksland. Derfor anses en spredning av hønsehirse innenfor Norge som mer sannsynlig enn etableringer fra nye innførsler av ugraset fra utlandet.

Hønsehirse er en sommer-ettårig plante som er avhengig av åpen åker for å overleve. Av denne grunn, og fordi populasjoner av hønsehirse har klart å etablere seg fra Aust-Agder i sør til Hedmark i nord, vurderes all åpen åker i lavlandet i Sørøst-Norge som utsatt område («endangered area») for hønsehirse. Det vil si at ut fra forholdene i disse områdene er det ikke noe i veien for etablering av hønsehirse, og en etablering av ugraset der vil kunne medføre betydelige negative konsekvenser. Det totale arealet som er infisert av hønsehirse i dag er grovt anslått til å utgjøre mindre enn halvparten av det utsatte arealet i Norge. For norsk jordbruk vurderes de negative konsekvensene ved en forekomst av hønsehirse som store i korn og potet, og svært store i grønnsaker. I mange eller alle av tilfellene vil avlingstapet kunne være betydelig eller svært betydelig, og det vil ofte eller alltid være behov for tiltak, blant annet bruk av plantevernmidler. Usikkerheten bak denne konklusjonen er høy på grunn av mangelfull dokumentasjon av skadeomfanget.

Abbreviations and/or glossary

Abbreviations

CABI (Centre for Agriculture and Biosciences International)

EFSA (European Food Safety Authority)

EPPO (European Plant Protection Organization)

EPPO PQR (EPPO Plant Quarantine Data Retrieval system)

FAO (Food and Agricultural Organization)

GPS (Global Positioning System)

NIBIO (Norwegian Institute of Bioeconomy Research)

NLR (Norwegian Agricultural Extension Service)

PRA (Pest Risk Analysis)

VKM (Norwegian Scientific Committee for Food Safety)

Glossary

The listed phytosanitary terms used in the current opinion are mainly according to ISPM No. 5 Glossary of phytosanitary terms by IPPC FAO (2015).

Endangered area: An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss.

Entry: Movement of a pest into an area where it is not yet present, or present but not widely distributed.

Establishment: Perpetuation, for the foreseeable future, of a pest within an area after entry.

Introduction: The entry of a pest resulting in its establishment.

Pathway: Any means that allows the entry or spread of a pest.

Pest: Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products.

PRA area: Area in relation to which a pest risk analysis is conducted.

Spread: Expansion of the geographical distribution of a pest within an area.

Background as provided by the Norwegian Food Safety Authority

Over the last few years, the species cockspur grass (*Echinochloa crus-galli*) has become a problem weed on arable land in some areas in Norway, particularly in the counties of Vestfold and Østfold. Cockspur grass, also called barnyard grass, has characteristics, which make it hard to control effectively. Hence, it is important to acquire knowledge about the species' potential of harm and spread. Moreover, it is important to get a general understanding of possible measures to prevent a potential further spread and establishment in other parts of the country.

Cockspur grass is a tropical or subtropical plant species, which originates from Asia. The species is an annual plant in the grass family, with an abundant seed production. The seeds can survive in the soil for more than 10 years, and the plant has modest requirements. It is classified as a C4-plant, and it can endure both droughts and dry soil, as well as wet years and moist or paddy soil.

According to FAO's (Food and Agricultural Organization's) home page, the species occurs as weed in tropical areas on cultivated land all over the world, from sea level up to 2500 metres above sea level. It stands out as a problem, particularly as a pest in rice. World-wide, cockspur grass is considered to be the third worst weed. According to the Norwegian Biodiversity Information Centre (Artsdatabanken), the species was first registered in Norway in 1878, on ballast in Fredrikstad, Østfold County. It was rare until 1970, but the weed has had a large increase in occurrence after 1988. The seeds are used, among other things, for bird feed. The species has been introduced to Norway through bird feed, ballast and imported seeds. Spreading of cockspur grass within Norway is likely with seeds for planting and in bird feed.

In Norway, the species is a weed problem, particularly in cereals, potatoes and vegetables. According to the NIBIO (Norwegian Institute of Bioeconomy Research) Encyclopedia on Plant Protection (Plantevernleksikonet) (Sjursen, 2012) hot and dry early summers, with poor growth of the cereals, will lead to an increased prevalence of cockspur grass. Several plant protection products control cockspur grass, but none of these products are registered for use in oat.

The County Governor of Vestfold and the Norwegian Agricultural Extension Service have brought up the issue of the serious weed problem that cockspur grass has become in the county of Vestfold, and they have expressed concern about further spread of the weed. Some areas have been left uncultivated, because of large occurrence of cockspur grass. The Norwegian Food Safety Authority has detected cockspur grass in seed lots from areas included in seed inspections for purity and identity. The Authority even has observed seeds of cockspur grass in some samples of oat.

The plant, being fairly novel as a problem weed in Norway, and about to spread to larger areas, may cause reduced crop yields, increased expenses in weed control and an increase in the use of plant protection products. More knowledge about the weed in Norway is needed, about the current situation, and about what to expect of further spread. It will also be useful to get information from other countries' measures against cockspur grass, including any public regulations. All relevant information, that can help to choose the best strategy for dealing with this weed, would be of interest to The Norwegian Food Safety Authority.

At the moment, there are no official regulations on cockspur grass in Norway, such as a duty to control it, or requirements of maximum contents in seed. Relevant regulations for this purpose are as follows:

1. Regulations on wild oat (*Avena fatua*)

The Norwegian Scientific Committee for Food Safety (VKM) made a pest risk assessment of wild oat in 2008 (VKM, 2008). The Norwegian Food Safety Authority prepared a proposal for a revision of the Regulations on wild oat (Landbruks- og matdepartementet, 2015), based on this risk assessment, among other factors, with the purpose to secure control and to prevent spreading of wild oat. The proposal includes several provisions which aim for this purpose, among them a duty to control wild oat on agricultural holdings. Furthermore, the proposal includes conditions and prohibitions concerning imports and sales of products containing wild oat, requirements for compulsory cleaning of machines etc., requirements as regards transport of products, as well as conditions on companies that receive cereals, peas or meadow seeds.

2. Regulations on seed

The purpose of this regulation (Landbruks- og matdepartementet, 1999) is to ensure production and sale of seed of the best possible health and quality, and to contribute to in situ preservation and sustainable use of plant genetic resources. The regulation requires, among other things, that seed lots of one species contain only a maximum percentage share of other species. There are also provisions determining maximum content of seeds of other specified plant species, in seed lot samples of a specified weight. The requirements of maximum content of seeds vary, depending on which species of seed to be produced. There is a zero tolerance for certain species of weed in cleaned seed ready for marketing. The Regulations on seed also contain requirements concerning inspections of wild oat in cereal seed production fields that are more severe than the requirements of self-inspection of wild oats on regular farmlands, established in the Regulations on wild oat. In the year of discovery it is not allowed to grow seeds of cereals or oilseed crops, smooth brome, meadow fescue, tall fescue, ryegrass or rye fescue in fields, where wild oats are found. To be able to grow seed of those species again, barley or spring wheat must be grown for two following seasons, the crops being subject to seasonal inspections following specific procedures, with no detection of wild oat.

3. Regulations relating to plants and measures against pests

The purpose of this regulation (Landbruks- og matdepartementet, 2000)is to prevent introduction and spread of plant pests, to control or eradicate outbreaks in Norway, and to safeguard the production and sale of plants and propagation material of the best possible health and satisfactory quality. The regulations are primarily about quarantine pests, with a large number of provisions to prevent the introduction of pests to Norway, and spread within Norway. A plant health certificate is required for imports of plants and items which can carry infestations of pests.

A pest risk assessment is necessary in order to consider whether the Norwegian Food Safety Authority ought to implement measures that reduce harmful effects following increased occurrence, spread and establishment of cockspur grass. If the VKM evaluation of relevant measures indicates that a regulation of cockspur grass would be an effective measure, the Norwegian Food Safety Authority will consider whether it is appropriate to prepare a regulation. In addition, the Norwegian Food Safety Authority assumes that the pest risk assessment will contain information about risk reducing measures that may be of interest to the farmers as well as the agricultural advisory services.

Terms of reference as provided by the Norwegian Food Safety Authority

1. Summarise current knowledge on the occurrence of *Echinochloa crus-galli* in Norwegian agriculture.
2. Identify pathways for entry and pathways for spread of the weed, and assess the relative importance of these pathways.
3. Assess the potential of further spread and establishment of the weed in Norwegian agriculture, including information about possible connection between spread and establishment of the plant, and the production method (crop, technique of cultivation etc.).
4. Assess the potential of harmful effect in Norway (yield reductions, reduced quality, the need for plant protection treatments etc.).
5. Identify and evaluate possible effective measures to prevent further spread and establishment, or to reduce harmful effects to the agriculture in Norway. If relevant, experiences in other countries should be pointed out.

Assessment

1 Introduction

1.1 Purpose and scope

This document presents an opinion prepared by the VKM Panel on Plant Health (hereafter referred to as the Panel), in response to a request from the Norwegian Food Safety Authority. The opinion is a risk assessment of the weed cockspur grass (*Echinochloa crus-galli*) in Norway. Furthermore, the opinion identifies and evaluates risk reduction options in terms of their effectiveness in reducing the plant health risk posed by this weed.

The PRA (Pest Risk Analysis) area of this risk assessment is Norway.

1.2 Information collection

1.2.1 Previous pest risk assessments

No previous pest risk assessments were identified in the search in WEB of Science (described in section 1.2.2), or in Google combining the search words *Echinochloa crus-galli* or cockspur grass or barnyard grass and PRA or risk assessment or risk evaluation or risk. No previous risk assessment was found on the web sites of EPPO (European Plant Protection Organization) or EFSA (European Food Safety Authority), or in the EFSA Information Exchange Platform. However, CABI (Centre for Agriculture and Biosciences International) has published a datasheet (last modified 21 October 2015) with information on *E. crus-galli* including a comprehensive reference list (CABI, 2015).

The Norwegian Biodiversity Information Centre has evaluated the ecological impact of *E. crus-galli* as an alien species in Norway (Artsdatabanken, 2016). They consider the weed to have a potentially high risk, as it is expansive and starting to become a serious weed in cereal and vegetable fields. Furthermore, they conclude that the weed does not invade less managed nature types, and it is not expected to do so in the future.

1.2.2 Literature search strategy

This section describes the literature search conducted for retrieving the scientific documentation available for this opinion.

A literature search was conducted in Web of Science™ in November 2015 and was last updated in March 2016. Appendix 1 gives an overview of the search strategy. Publications of all ages and languages were included in the search. The search gave 1056 hits. One expert

of the project group did a first scanning of all titles. Thereafter, the same expert scanned all abstracts of those publications that were found relevant. The criteria for selection of publications, when scanning titles or abstracts were:

- Relevance for Nordic conditions
- Topics describing biological traits
- Topics describing adaptation to cold condition
- Description of invasiveness and adaptability
- Herbicide resistance, limited to herbicides available in Norway
- Pathways for entry or spread

If additional relevant references were discovered (e.g. in publication reference lists), these were included. Additional literature was also retrieved by the members of the project group, due to their expertise on the subject.

1.2.3 Data collection

The different data used in the current risk assessment and how they were collected are listed and described here.

During the growing season of 2015, the agricultural departments at the County Governors of Vestfold and Østfold counties, in cooperation with the municipal agricultural offices, conducted a survey of the occurrence of *E. crus-galli* in the two counties. The survey data was made available to VKM. Both counties have a long history of *E. crus-galli* infestation and are the most heavily infested areas in Norway. In Østfold County the survey was only done in the municipality of Fredrikstad, while in Vestfold County the survey was conducted in selected areas with known occurrence of the species, and where the species had been described as abundant. In September 2015, VKM received a copy of this survey database containing a total of 933 field records containing locations of species occurrence with geographical coordinates measured with GPS.

All field records of *E. crus-galli* available from the Norwegian Biodiversity Information Centre were downloaded in December 2015 from their online and open database service (Artsdatabanken, 2015).

In November 2015, VKM sent an inquiry for expert opinions about the status of *E. crus-galli* infestation in other counties of Norway, other than Vestfold and Østfold, with large areas of arable cropping. The questionnaire was sent to the County Governor (Fylkesmannen) of Buskerud, and to eight local units of the Norwegian Agricultural Extension Service (Norsk Landbruksrådgiving): Rogaland, Agder, Øst, Solør-Odal, Hedmark, Oppland, Sør-Trøndelag, and Nord-Trøndelag (Appendix 3). The municipalities where infestations have been recorded were identified by follow-up phone calls to the respondents. Answers were received from all counties except Oppland.

Information on occurrence in new lawns, established with mixtures of local soil resources by enterprises in the municipalities of Sandefjord and Larvik was obtained from the County Governor of Vestfold.

Information on occurrences of *E. crus-galli* in Norway was also retrieved from articles in farmers' magazines, newspapers, web-sites, previously reported surveys etc. Occurrences of *E. crus-galli* were reported incidentally in "newsletters to farmers" from the Norwegian Agricultural Extension Service units in South East of Norway (Viken, SørØst, Romerike and Hedmark) during the summers 2014 and 2015.

Data from surveys of *E. crus-galli* seeds in Norwegian certified seed of cereals, clover and grasses detected in purity tests in the laboratory during the years 2000-2014, and occurrences observed during field inspection of cereal seed production during 2012-2015, were provided by the Norwegian Food Safety Authority. With permission from the seed companies (Felleskjøpet Agri, Strand Unikorn), Kimen Seed Laboratory (Kimen Såvarelaboratoriet AS) provided findings of *E. crus-galli* seeds from purity analyses of samples from seed lots harvested from the above mentioned infested seed production fields.

Occurrences of *E. crus-galli* seeds in imported and Norwegian seed lots analyzed for purity (including content of weed seeds) during the 1980-ies were available in annual reports from the Norwegian State Seed Testing Station during the 1980-ies (Norwegian State Seed Testing Station, 1985; Norwegian State Seed Testing Station, 1986; Norwegian State Seed Testing Station, 1987; Norwegian State Seed Testing Station, 1988; Norwegian State Seed Testing Station, 1989).

Data on import volume (tonnes) of cereal and rye grass seeds for planting in the years 2010 to 2015 were provided by the Norwegian Agricultural Agency, through the Norwegian Food Safety Authority.

Findings of *E. crus-galli* seeds in imported bird seeds products were obtained from the Norwegian Agricultural Extension Service, Viken (Norwegian Agricultural Extension Service Viken, 2014). Kimen Seed Laboratory provided general information on the occurrence of *E. crus-galli* seeds in imported bird seeds. Country of origin and number of bird seed lots imported into Norway during the years 2010 to 2015 were provided by Kimen Seed Laboratory.

Current Norwegian prices on herbicides were provided by Felleskjøpet Agri.

During the period November 2015-February 2016 VKM sent inquiries to relevant experts for opinions about the status of *E. crus-galli* infestation in Denmark, Finland and Sweden. VKM received answers to the questionnaire from Finland and Sweden (Appendix 4). Information from Denmark was obtained by personal communication with Peter Hartvig, Århus University.

General information on biology, habitats, distribution, importance, yield loss etc. of *E. crus-galli* was obtained from CABI's datasheet on *E. crus-galli* (CABI, 2015) and the Norwegian Biodiversity Information Centre's evaluation of the ecological impact of *E. crus-galli* as an alien species in Norway (Artsdatabanken, 2016) (section 1.2.1) and from the literature search described above (section 1.2.2). Information was also retrieved by personal communications with persons with knowledge on cockspur grass. Where these information sources have been used, this is indicated in the text by references enclosed in brackets.

1.3 Ratings of probabilities and uncertainties

The conclusions for probability of entry, establishment and spread of the weed are presented and rated separately, following a fixed scale: very unlikely, unlikely, moderately likely, likely, very likely. The descriptors for these qualitative ratings are shown in Appendix 2.

The conclusion for impact of the weed to the Norwegian agriculture is presented and rated separately, following a fixed scale: minimal, minor, moderate, major, massive. The descriptors for these qualitative ratings of economic consequences are shown in Appendix 2.

For the risk assessment conclusions on entry, establishment, spread and impact, the levels of uncertainty are rated separately, following a fixed scale: low, medium, high. The descriptors for these qualitative ratings of uncertainty are given in Appendix 2.

2 Weed identity and status

2.1 Identity of weed, name and taxonomic position

For this section, information on scientific names and taxonomic position of the weed were obtained from the CABI datasheet on *E. crus-galli* (CABI, 2015). Common names were obtained from EPPO PQR in November 2015 (EPPO PQR, 2013). Information on identification of the species was obtained from the NIBIO Encyclopedia on Plant Protection (Sjursen, 2012).

Preferred scientific name

Echinochloa crus-galli (Linnaeus) Palisot de Beauvois

Other scientific names

- *Echinochloa caudata* Roshev.
- *Echinochloa commutata* Schult.
- *Echinochloa crus-corvi* (L.) P.Beauv.
- *Echinochloa dubia* Roem. & Schult.
- *Echinochloa echinata* (Willd.) Nakai
- *Echinochloa formosensis* (Ohwi) S.L.Dai
- *Echinochloa hispida* (E.Forst.) Schult.
- *Echinochloa hispidula* (Retz.) Nees ex Royle
- *Echinochloa macrocorvi* Nakai
- *Echinochloa madagascariensis* Mez
- *Echinochloa micans* Kossenko
- *Echinochloa muricata* (P. Beauv.) Fern.
- *Echinochloa occidentalis* (Wiegand) Rydb.
- *Echinochloa paracorvi* Nakai
- *Echinochloa spiralis* Vasinger
- *Echinochloa subverticillata* Pilger
- *Milium crus-galli* (L.) Moench
- *Oplismenus crus-galli* (L.) Dumort.
- *Oplismenus dubius* (Roem. & Schult.) Kunth
- *Oplismenus echinatus* (Willd.) Kunth
- *Panicum crus-galli* L.
- *Panicum hispidulum* Retz.
- *Pennisetum crus-galli* (L.) Baumg.

Common names

Hønsehirse (NO), hönshirs (SE), hanespore (DA), Hahnenkammhirse (DE), Hühnerhirse (DE), gemeine Hühnerhirse (DE), cockspur (UK), cockspur grass (UK), common barnyard grass (UK-USA).

Taxonomic position

- Domain: Eukaryota
- Kingdom: Plantae
- Phylum: Spermatophyta
- Subphylum: Angiospermae
- Class: Monocotyledonae
- Order: Cyperales
- Family: Poaceae
- Genus: Echinochloa
- Species: Echinochloa crus-galli

EPPO code: ECHCG (Echinochloa crus-galli)

Identification of the weed

The identification of the weed is described by Sjursen (2012).

2.2 Occurrence of the weed in the PRA area

As stated in section 1.1, the PRA area of the current risk assessment is Norway.

Echinochloa crus-galli is widely distributed in fields of cereals, potatoes and various vegetable crops in the counties of Østfold and Vestfold (Berntsen, 2015; Evju, 2014; Norwegian Agricultural Extension Service Viken, 2014; Sørlie Yri, 2015; Øverland, 2011; Øverland, 2012a; Øverland, 2012b), which are the most densely *E. crus-galli*-infested regions of Norway. A map of municipalities with confirmed infestations in these counties, as well as in other counties, is shown in figure 1, together with municipalities with infestations recorded during inspections of cereal seed production fields.

Figure 1: Municipalities with infestation by cockspur grass (*Echinochloa crus-galli*) on agricultural areas in Norway. Findings confirmed by Municipal and County Agricultural Offices, Norwegian Agricultural Extension Service and personal observations by Jan Netland are shown as hatched. Observations from inspection of cereal seed production fields, provided by the Norwegian Food Safety Authority are shown in green. Infestations confirmed by both sources are shown in hatched green.

Table 1: Results of VKM's inquiry for expert opinions regarding the status of *E. crus-galli* infestation on agricultural areas in Norway other than the counties of Vestfold and Østfold. The inquiry was made during the period of November 2015 to February 2016 (Appendix 3). The municipalities where infestations have been registered have been identified by follow-up phone calls to the respondents.

County	**Rogaland**	**Aust-Agder**	**Buskerud**	**Akershus + Oslo[2)]**	**Hedmark [3)]**	**Trøndelag [4)]**
Survey[1]	No	No	No	No	No	No/Yes[5)]
Findings	No	Yes	Yes	Yes	Yes	No
Findings for how long		1 year	2-3 years	5-6 years	at least 2-3 years	
Municipalities with findings		Grimstad	Kongsberg, Modum, Øvre Eiker, Nedre Eiker	Ullensaker Oslo	Åsnes, Ringsaker	
Number of farms with findings		2-3	>10	4-10	2	
Crop rotation		cereal/ vegetables	cereal mono cropping; cereal/potato; cereal/vege-tables; cereal/oil seeds	cereal mono cropping	cereal mono cropping; cereal/ley	
Infested area		½-5 daa	>5 daa	>10 plants	> 5 daa	
Use of herbicide (number of farms)		1-3	>10	1-3	2	
Number of seed producers		0	0	0	1	

[1)] No systematic surveys have been carried out for the whole counties, but in some municipalities findings have been recorded. [2)] This column contains information from two respondents from the Norwegian Agricultural Extension Service Øst: One for the regions of Romerike and Oslo and one for the Follo region (the latter contacted by phone). [3)] This column contains information from two respondents from Hedmark County: The Norwegian Agricultural Extension Service of Solør-Odal-Eidskog and of Hedmark. [4)] This column contains information from two respondents: The Norwegian Agricultural Extension Service of Nord-Trøndelag (shown in appendix 3) and of Sør-Trøndelag (the latter gave their answer by phone). [5)] Some registration work has been carried out in Nord-Trøndelag County, but no findings have been recorded.

Information on established infestations in other counties than Østfold and Vestfold is shown in table 1. According to the respondents, most of the findings have been treated with herbicides. This indicates that these occurrences are heavy infestations too laborious to control by hand weeding. Especially in Buskerud County (the municipalities of Kongsberg, Modum, Øvre Eiker, Nedre Eiker) the number of farms with occurrences, and with a need for herbicide treatment, was high. Some competitive infestations of *E. crus-galli* in agricultural fields have also been reported from Akershus County (Ullensaker municipality), Hedmark County (Ringsaker and Åsnes municipalities), Aust-Agder (Grimstad municipality) and Oslo.

A survey performed during the growing season of 2015, by the agriculture departments of the County Governors of Vestfold and Østfold counties, in cooperation with the municipal agricultural offices, shows that *E. crus-galli* was present in fields with a variety of crops, demonstrating the flexibility of the weed, see figure 2. The majority of infestations were observed in cereals and potato. But relative to area the weed is more common in carrot and onion, than in cereals. The high frequency of the weed in Norwegian wheat, barley and oat fields is different from Denmark, Finland and Sweden.

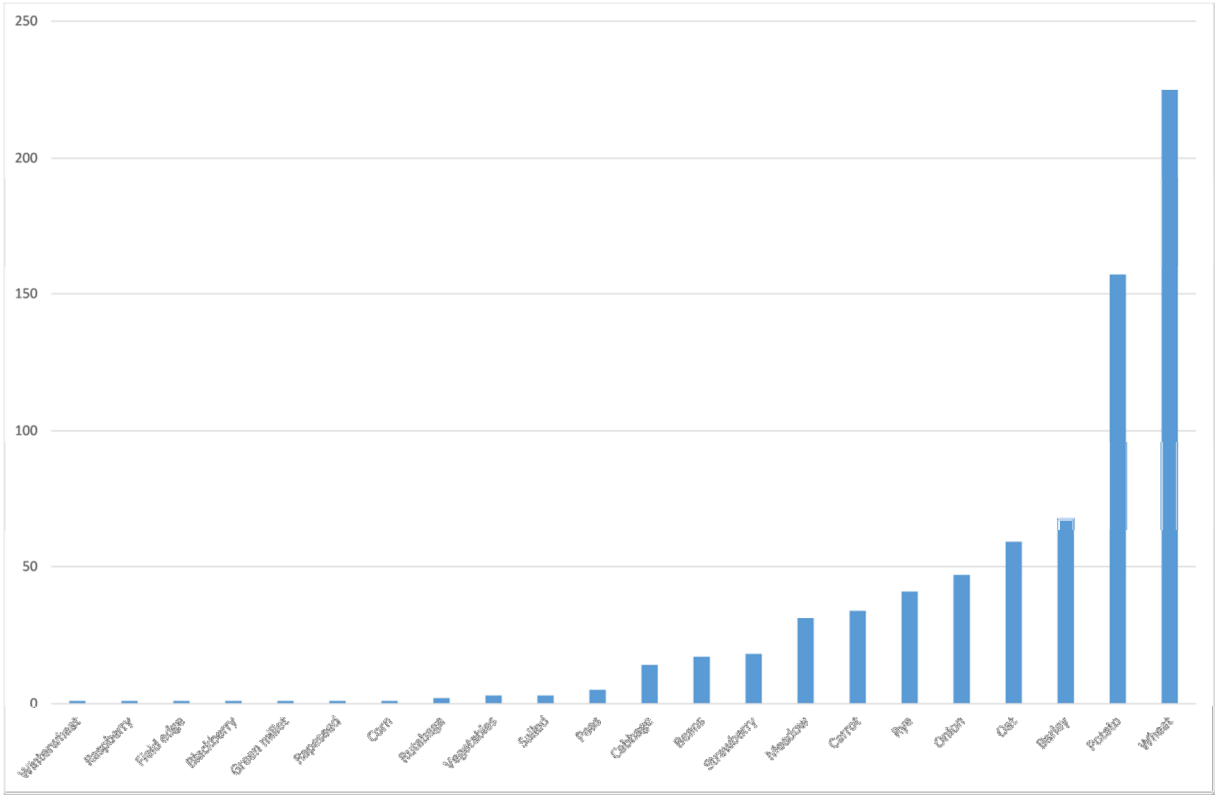

Figure 2: Numbers of field records distributed over different crops in the counties of Østfold and Vestfold (N=933). Data source: A survey performed during the growing season of 2015 in the counties of Vestfold and Østfold. The survey is described in section 1.2.3.

Occurrence in Norwegian seed production

In laboratory tests (purity) of certified Norwegian seeds for planting, cockspur grass seeds have only been detected during recent years in a few seed lots of oats and wheat (table 2). In 2011, one oat seed lot out of 382 lots contained 17 seeds per kg. In 2013, four out of 418 seed lots contained on average 13 seeds per kg, and in 2014, one spring wheat seed lot contained 12 seeds per kg. Cockspur grass seeds were not detected in any seed lots of barley, rye, grasses, or clover during the years from 2000 – 2014 (table 2).

Table 2: Number of seed samples from Norwegian certified seeds during the years 2000-2014, where seeds of *E. crus-galli* were detected (data provided by the Norwegian Food Safety Authority).

Species	2000-2010	2011	2012	2013	2014
Barley	0	0	0	0	0
Oat	0	1[1]	0	4[2]	0
Wheat	0	0	0	0	1[3]
Rye	0	0	0	0	0
Grasses	0	0	0	0	0
Clover	0	0	0	0	0

[1)] 17 seeds pr kg oat seed, from a total of 382 samples; [2)] in average 13 seeds pr kg oat seed, from a total of 418 samples; [3)] 12 seeds pr kg wheat seed, information on total number of samples is not given.

At the inspections of cereal seed production fields during 2012-2015, cockspur grass was reported from 22 fields (out of totally 2459 fields). The municipalities of the fields are shown in figure 1. In Vestfold County, occurrence of cockspur grass was reported in one field in 2012 (spring wheat), in four fields in 2013 (two oat, one barley, one spring wheat), in one field in 2014 (barley) and in one field in 2015 (barley). In Østfold County, the weed was reported in two fields in 2013 (one winter wheat, one barley), four fields in 2014 (two oat, two spring wheat) and in six fields in 2015 (three spring wheat, one winter wheat, one barley and one oat). In 2015, cockspur grass was also observed in one field in Akershus County (winter wheat), one field in Telemark County (barley) and in one field in Hedmark County (barley). In the harvested seed lots from these infested fields, *E. crus-galli* seeds were detected only in one lot of spring wheat (12 seeds pr kg seed) produced in 2014 in Rygge municipality, and in one lot of oat (two seeds pr kg seed) produced in 2015 in Fredrikstad municipality, both in Østfold County. No *E. crus-galli* was detected in the seed lots used for sowing of the 22 fields reported with *E. crus-galli* occurrence in the field inspection. During the season 2015/2016, Kimen Seed Laboratory observed *E. crus-galli* in samples from one spring wheat seed lot (two seeds per kg seed) from Nøtterøy municipality in Vestfold County, however, occurrence of *E. crus-galli* was not reported from inspection of the production field.

Other findings

In 2001-2002, *E. crus-galli* was observed at two wholesale woody plant nurseries, Grefsheim and Baldishol at Nes, Hedmark County (Often et al., 2003). The weed was especially found in *Rosa* sp., imported from Denmark, and rooted in containers with soil. Often et al. (2003) also mentioned occurrences of the weed in connection with greenhouse production at Lier, Buskerud County and at Stokke, Vestfold County. In 1991 and 1995 NIBIO (at that time Planteforsk), performed two investigations on content of weed species in ornamental plants rooted in containers with soil (Brandsæter et al., 1991; Netland et al., 1995). The imported samples were collected on arrival in Norway from Denmark, Germany, the Netherlands and Poland. Samples were also collected from Norwegian nurseries. *Echinochloa crus-galli* was not found in any of the samples.

Moreover, the weed was observed in a cereal field in Ås municipality, Akershus County in 2013 (personal observation, Jan Netland, NIBIO), and heavy infestations of the weed were observed in a new lawn in Larvik municipality, Vestfold County in 2015 (personal communication, Einar Kolstad, Larvik Municipality).

Historical records

The first occurrences of *E. crus-galli* in Norway date back to before year 1900 with a few findings located in West Norway, Oslo area, Fredrikstad and South Norway (Figure 3). These early observations were often only single plant registrations (Artsdatabanken, 2015). Fifty years later, more observations of the weed were recorded (Figure 3) and after another 50 years even more records were included.

Since the 1970-ies, *E. crus-galli* has been a weed issue in vegetable growing areas both east and west of the Oslo Fjord (Figure 3). This development was confirmed by Bylterud (1980) and Sjursen (1993). The area is characterized by mild climate and sandy soil. As an example of the problem, Bylterud (1980) mentioned that a farmer at Jeløya, Østfold County needed to fallow some areas because of heavy infestation of *E. crus-galli*. Balvoll (1985) reported the weed to be troublesome in the counties of Vestfold and Østfold. A weed survey on the occurrence of important annual weed species on arable land in Norway 1947-1973 (Fiveland, 1975), and a study of occurrence of weeds in imported and Norwegian grown grass seeds (Ekerholt Dysvik, 1979), do not mention *E. crus-galli*. This indicates that *E. crus-galli* was not a common weed in Norway until the late 1970-ies.

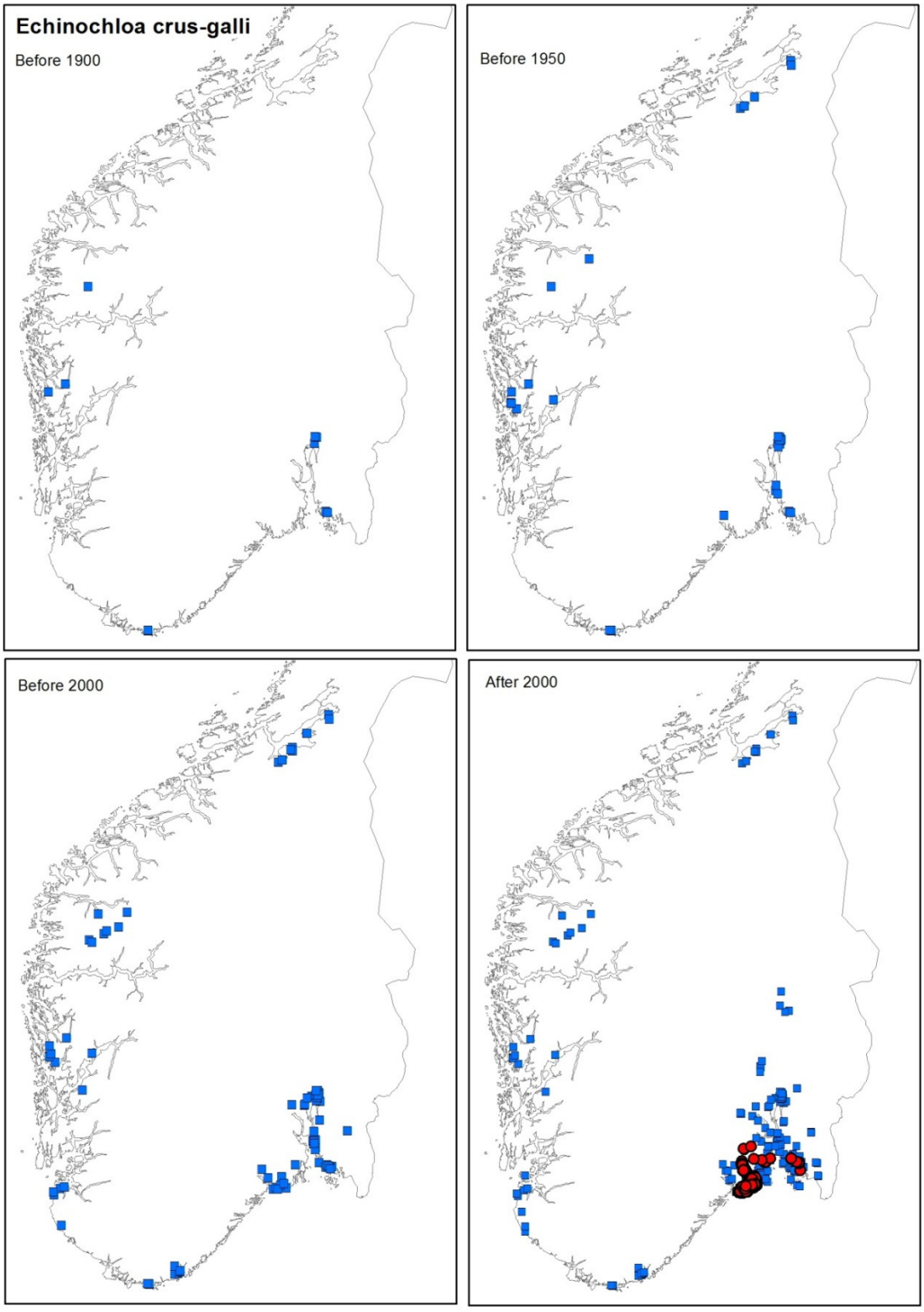

Figure 3: Historical records of *E. crus-galli* in Norway (blue squares). Cumulative records over time. Data source: The Norwegian Biodiversity Information Centre (Artsdatabanken, 2015). The lower right panel includes also the data (N=933) collected in a survey performed during the growing season of 2015 in the counties of Vestfold and Østfold (red circles). The survey is described in section 1.2.3.

In 1989, a questionnaire on occurrences of *E. crus-galli* in agricultural regions along the Oslo Fjord area, the coastal areas of southern Norway and Trøndelag, showed that the coastal regions of Østfold, Vestfold and Aust-Agder counties were most seriously infested by the weed (Sjursen, 1993) (Table 3). In 1992, occurrences of the weed were confirmed in the municipalities of Råde, Rygge and Fredrikstad in Østfold County and in Akershus County (Sjursen, 1993).

Table 3: Answers given as a response to a questionnaire about occurrences of *E. crus-galli* sent by the former Norwegian Plant Protection Institute (Statens plantevern) in 1989 to 54 selected Agricultural Offices and 13 local units of the Norwegian Agricultural Extension Service in the Oslo Fjord area, along the Skagerak coast, and in the regions of Sørlandet, Jæren and Trøndelag. The response rate was about 60 %.The table shows the answers from those offices that confirmed occurrence of cockspur grass in their regions (Sjursen, 1993).

County	Agricultural Office/ Extension Service	Crop	Soil type
Østfold	Onsøy Skjeberg	Cerelas Barley, wheat, vegetables	Morain soil Clay, sandy soil
	Jeløy og omland	Cereals, maize, potato, carrot, crusiferous crops, field cucumber, turnip rooted parsley	Sandy soil on moist locations
Vestfold	Larvik Nøtterøy/Tjøme	Cereals, potato, etc. Cereals, onions, carrot, celery	Sandy soil, humus-rich sandy soil, clay soil
	Sandefjord Tønsberg	Barley, wheat, onion Onion, carrot	Sandy soil, morain soil
Aust-Agder	Arendal og Grimstad	Onion, carrot	Humus-rich soil, light sandy soil, marshland
Vest-Agder	Sogndalen og Søgne	Only sporadic registrations	

2.3 Regulatory status

Cockspur grass is not regulated in Norway. The species is not included in EPPO's A1 or A2 list. To our knowledge there are no regulations of the weed in any country.

On July 1st 1982, *E. crus-galli* was defined as a noxious weed in the Regulation on Seed (Norwegian State Seed Testing Station, 1983). A tolerance of maximum 100 *E. crus-galli* seeds/kg seeds was decided for the 1984/1985 season, and from July 1st 1985, zero tolerance of *E. crus-galli* was established for traded seeds (Norwegian State Seed Testing Station, 1986). However, the seed companies were not able to produce carrot seeds free of *E. crus-galli*. Derogation was therefore given from the seed regulation for the 1985/1986-season, with a maximum content of 75 *E. crus-galli* seeds allowed /kg carrot seed. From the analysis season 1988/89, *E. crus-galli* was defined as noxious only in carrot, with a maximum content of 100 seeds allowed/kg carrot seed (Norwegian State Seed Testing Station, 1986). From 1993, the Norwegian Regulation on Seed was adjusted to the EU Regulations. During the public hearing of the new regulations, the Norwegian Plant Protection Institute expressed concern that certain serious weeds, like cockspur grass, was not mentioned. The institute

stated that the weed was troublesome in arable crop fields, and that it was well known that the weed was easily imported by contaminated vegetable seeds, resulting in serious and long-standing problems for farmers. However, the cockspur grass was not considered a serious weed in other European countries and, therefore, not included in the new regulations.

3 Assessment of the probability of introduction and spread

The origin of *E. crus-galli* remains obscure, but it is probably native to tropical Asia (USDA-ARS, 2014). According to CABI (2015), *E. crus-galli* has a distribution extending from northern Europe, to the subtropics and to tropical regions from 50°N to 40°S. It is widespread in Europe, Asia and Australia, although is scarce in Africa. *Echinochloa crus-galli* has been reported as a weed in 61 countries.

Echinochloa crus-galli spreads only by seed, and its high capacity for seed production allows large populations to rapidly establish. Seeds can be dispersed by wind, water or as a contaminant in soil, seed crops, and on agricultural machinery (CABI, 2015). This grass is a cosmopolitan weed which has been introduced repeatedly in tropical and subtropical regions where it sometimes is as fodder and forage (CABI, 2015). When growing under suitable environmental conditions (i.e., moist soils), the weed spreads rapidly and produces large amounts of seeds which can germinate or remain in the seed bank for several years (CABI, 2015).

3.1 Probability of entry of the weed

The special case when a species is crossing a country border is in the terminology of PRA classified/denominated as an "entry" event, while further spread inside the actual country or administrative unit, is denominated as spread (see glossary).

3.1.1 Identification of pathways for entry

Possible pathways for entry of cockspur grass from outside the PRA area are:

- Vegetable seeds for planting
- Cereal seeds for planting
- Grass and legume seeds for planting
- Bird seeds
- Ornamental plants rooted in soil
- Growth media

Seeds for planting

Maun and Barrett (1986) claimed that cockspur grass seed is a common contaminant of many seed crops, and weed seeds are often introduced to fields during the sowing of the crop.

Norwegian vegetable production was during the 1970-ies and 1980-ies to a large extent based on imported seeds. Bylterud (1980) suggested defining *E. crus-galli* as a "noxious" weed, with reference to that classification of the weed in more southern countries. The purpose was to avoid import of seed lots containing *E. crus-galli* seeds. It was at that time not found in Norwegian (domestic) produced seed lots, but it was sometimes observed in imported seeds of carrot, onion and ryegrass. Balvoll (1985) also claimed that the weed probably was introduced into Norway as contaminant in onion and carrot seed lots. The weed had been observed for some years at several Norwegian farms, growing onion set (grown from seed). In a large consignment of carrot seed marketed in 1984 approximately 1200 *E. crus-galli* seeds/kg carrot seed was found. Sjursen (1993) suggested imported vegetable seeds (especially carrot and onion) to be an important pathway.

According to the annual reports of the Norwegian Seed Testing Station (Norwegian State Seed Testing Station, 1985; Norwegian State Seed Testing Station, 1986; Norwegian State Seed Testing Station, 1987; Norwegian State Seed Testing Station, 1988; Norwegian State Seed Testing Station, 1989), it was stated that the weed was established in some locations in southern parts of Eastern Norway. The weed was especially common in imported carrot seed lots, with as much as 2500 *E. crus-galli* seeds per kg seed, but it was recorded also from imported seed samples of ryegrass and other species. During the analysis season 1985/1986, *E. crus-galli* was detected in 18 seed samples of carrot, in eight ryegrass samples, one sample of dill (*Anethum graveolens*) and one sample of lacy phacelia (*Phacelia tanacetifolia*). The previous season the weed was detected in one seed sample of timothy (*Phleum pratense*), with 133 *E. crus-galli* seeds/kg. During the season 1986/87 *E. crus-galli* seeds were recorded in 12 seed samples of carrot, three seed samples of ryegrass, one dill (*Anethum graveolens*) sample, one sikory (*Cichorium intybus*) sample and one lacy phacelia (*Phacelia tanacetifolia*) sample. During the season 1987/88 *E. crus-galli* seeds were recorded in 17 seed samples of carrot, seven of ryegrass, two of red fescue, two of leek, two of lacy phacelia, and one each of Hungarian brome (*Bromus inermis*), alfalfa (*Medicago sativa*) and wild rye (*Secale multicaule*).

All this information makes it quite clear that a massive entry of *E. crus-galli* into Norway took place in the 70-ties and 80-ties through imported vegetable seeds for planting. It is likely that these entries are the origin for the heavy infestations of well adapted biotypes in Østfold and Vestfold counties today.

Bird seeds

Bird seeds have been identified as a pathway for the introduction of weeds, including *E. crus-galli* (Artsdatabanken, 2016; CABI, 2015; EPPO, 2007a; EPPO, 2007b).

Balvoll (1985) suggested that the weed probably was introduced into Norway in forage grain or bird seed. Sjursen (1993) claimed that an occurrence of *E. crus-galli* in Akershus County in 1992 was confined to bird seed.

Ornamental plants rooted in soil

In 2001-2002, *E. crus-galli* was observed at two wholesale woody plant nurseries, Grefsheim and Baldishol, both at Nes, Hedmark County (Often et al., 2003). The weed was especially common in the soil of *Rosa* spp. imported from Denmark. Often et al. (2003) also mentioned occurrences of the weed in connection with greenhouse production in the municipality of Lier in Buskerud County and in the municipality of Stokke in Vestfold County.

Growth media

It is assumed that peat and bark products as growth medium do not contain *E. crus-galli*. Compost soil might contain the weed, but is to our knowledge not imported. Therefore, growth media are not considered as a relevant pathway.

3.1.2 Probability of the weed being associated with the pathway at origin

Seeds for planting

Except for ryegrass, Norwegian import of grass and cereal seed is modest and variable (see table 4), and imported seed is only planted on a small part of the total arable area. The total use of cereal seeds for planting in Norway is approximately 60 000 tonnes annually. Both in cereals, grasses and legumes cleaning the seed lots for *E. crus-galli* contamination should be achievable, but currently there are no controls or inspections to verify that the seed lot is free of *E. crus-galli*. Although the *E. crus-galli* seed has not been found in recent years in imported grass and legume seeds it might be a pathway if seeds of these species are imported from countries were the weed occurs abundantly.

Table 4: Import volume (tonnes) of cereal and ryegrass seeds for planting in the years 2010 to 2015. Data provided by the Norwegian Agricultural Agency.

Culture	2010	2011	2012	2013	2014	2015
Wheat			1 451	1 426	39	134
Rye			80	545	1 068	1 025
Barley			6 559	592	196	44
Oat			3 838	5 213	4 231	177
Maize	2	7	8	4	2	6
Ryegrass	618	690	698	1 295	1 036	730

Norwegian vegetable production still depends largely on imported seeds for planting. During the 1970-ies and 1980-ies the supply of vegetable seeds was sometimes highly contaminated with *E. crus-galli* seeds as described in 3.1.1. Today, more effective herbicides are likely to be used in the seed producing countries, and the seed cleaning procedures and the quality of the production line have presumably improved since the mid-nineties. In addition, vegetable seed are often pelleted. Figure 4 shows that new recordings of *E. crus-galli* in Norwegian carrot fields have not been reported in recent years.

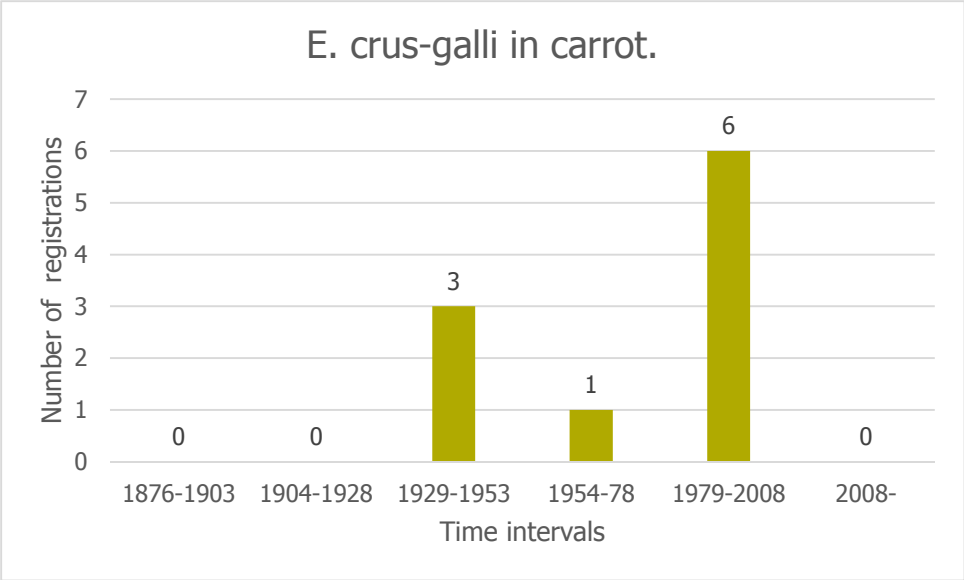

Figure 4: Registration of *Echinochloa crus-galli* in carrots fields in Norway. The Norwegian Biodiversity Information Centre (Artsdatabanken, 2015).

Bird seeds

The European market accounts for 25-30% of the world market for bird seed, and the trade is based primarily in UK, Netherlands, Belgium, Sweden, Norway and Italy. The origin of import to Europe is difficult to track, because there is no common statistics. But a great part apparently comes from Africa and Asia (Fitzpatrick and De Baaij, 2013).

Bird seed imported to Norway is inspected for occurrence of wild oat (*Avenae fatua*) and hemp (*Cannabis sativa*), which are not allowed in imported seed. Because there are no regulations on *E. crus-galli*, no systematic data on occurrences in bird seeds is available. However, Kimen Seed Laboratory, which is doing the analyses, sometimes observes seed of *E. crus-galli* in imported bird seed samples (personal communication, Kimen Seed Laboratory). Furthermore, in the winter 2013/14, three imported bird seed samples were analysed on behalf of the Norwegian Agricultural Extension Service Viken, and a high number of *E. crus-galli* seeds were detected in two of the samples (Norwegian Agricultural Extension Service Viken, 2014).

Table 5 shows the countries, from where the bird seed products are imported into Norway. However, the different seed species of the products are not necessarily produced in these countries, and information of origin of the different species is not available. Bulgaria has been the dominating country, from where sunflower for bird seed was imported to Norway during the last six years (Kimen Seed Laboratory). *Echinochloa crus-galli* is reported to be one of the most important weeds in Bulgaria (DAISIE, 2016; Holm et al., 1977; Stoimenova and Mikova, 1992). It is likely that the *E. crus-galli* seed is associated with imported sunflower seed from that country.

Table 5: Number of bird seed lots imported to Norway during the years from 2010 to 2015 (Source: Kimen Seed Laboratory)

Country	2010	2011	2012	2013	2014	2015	Total number
Argentina	36	10					46
Australia	71	44	80	54	24	27	300
Belgium	29	16	24	14	26	6	115
Bulgaria	301	199	225	300	266	266	1557
Denmark	36	127	118	130	118	62	591
Germany	5				9	7	21
Hungary	29	25	14	14	7	9	98
Netherlands	4		38	34			76
Poland					4		4
Slovakia				2			2
Sweden	69	84	54	71	43	25	346
Total number	580	505	553	619	497	402	3156

According to national weed surveys in Hungary during the last 50 years, *E. crus-galli* jumped from 9th to the 2nd most important weed in 1996-1997 (Nagy and Földesi, 2007). Hungary was, during the 1980-ies and 1990-ies, an important country for sunflower bird seed import to Norway (Kimen Seed Laboratory). Bird seed is still imported to Norway from Hungary, and there are reasons to suspect that *E. crus-galli* seed occurs as a contaminant in these consignments. In addition to Bulgaria and Hungary, *E. crus-galli* is reported to be present in all other countries exporting bird seed to Norway (table 5) (CABI, 2015; DAISIE, 2016; Holm et al., 1977).

It is likely that bird seed lots, imported previously, have contained *E. crus-galli* seeds, and that bird seed still is contaminated by the weed. To cause problems in the field the bird seeds need to be transported to a suitable growing place, preferably directly to an agricultural field. Figure 5 shows that the number of *E. crus-galli* findings on waste deposits has increased during the last years. This indicates that *E. crus-galli*-infestations on waste deposits could be a possible link between places for feeding birds to agricultural fields.

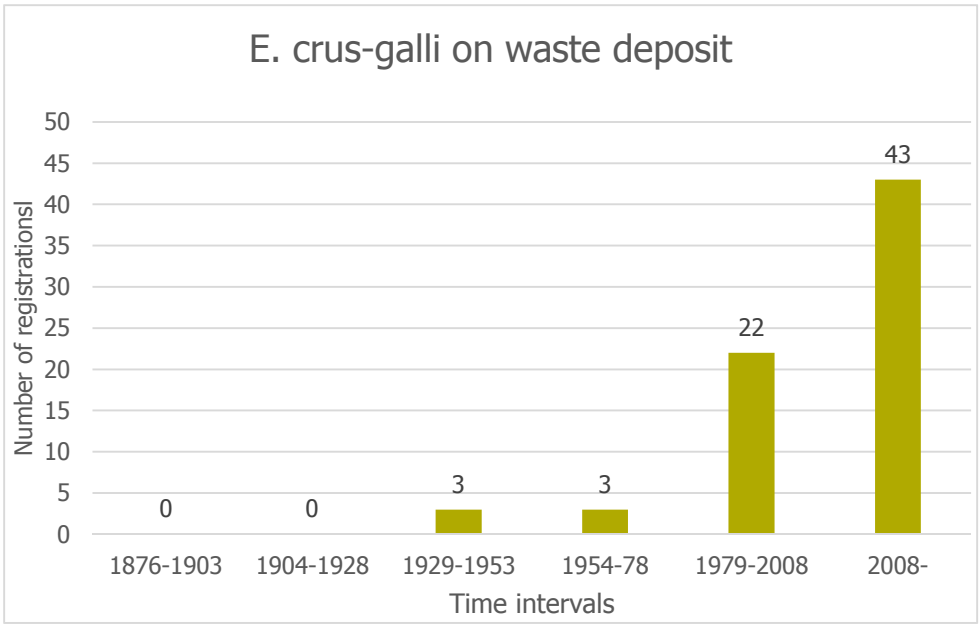

Figure 5: Registration of *Echinochloa crus-galli* in waste deposits. Source: The Norwegian Biodiversity Information Centre (Artsdatabanken, 2015).

In summary

Table 6 summarises the pathways for entry identified in section 3.1.1, and the probability of *E. crus-galli* to be associated with these pathways at origin.

Table 6: A list of identified pathways for entry of *E. crus-galli* into Norway, and an assessment of the probability of the weed being associated with each of the identified pathways at origin.

Pathway for entry	**Probability of association at origin**
Vegetable seeds for planting	Unlikely Uncertainty: medium
Cereal seeds for planting	Unlikely Uncertainty: low
Grass and legume seeds for planting	Moderately likely Uncertainty: high
Bird seeds	Very likely Uncertainty: low
Ornamental plants rooted in soil	Moderately likely Uncertainty: Medium

3.1.3 Probability of survival during transport or storage

The probability of survival of *E. crus-galli* during transport or storage is considered to be very likely, because no measures that kill the weed seed occur during the transport or storage. The uncertainty of this conclusion is low.

3.1.4 Probability of weed surviving existing pest management procedures

Echinochloa crus-galli is not regulated in the PRA area, and there are no mandatory measures directed towards this species. Also, *E. crus-galli* is not affected by existing pest or weed management procedures against other pests applied to consignments that might contain *E. crus-galli*.

3.1.5 Conclusions on the probability of entry

In conclusion, the probability of entry of *E. crus-galli,* from countries outside of the PRA area to a suitable habitat within the PRA area, is considered as moderately likely. The uncertainty of this conclusion is medium. (See Appendix 2 for rating scales for entry and uncertainty).

The overall assessment behind this conclusion is that *E. crus-galli* is frequently associated with pathways for entry (especially by bird seeds), the weed survives during transport and storage, and it is not affected by existing pest management procedures applied to consignments that might contain *E. crus-galli*.

3.2 Probability of establishment

As mentioned earlier, *E. crus-galli* is already present in parts of the risk assessment area. The species has been present for a long period of time (Figure 3). Current populations of *E. crus-galli* in Norway could either be classified as established populations or just random annual occurrences (i.e. temporary/transient populations). Based on the many years of presence in Norway (see section 2.2), the conclusion is that cockspur grass must be regarded as established in Norway. Another indication of establishment is that the species has expanded its geographical distribution in the country. This is especially evident in the Oslo Fjord region, where the species in recent years has expanded its distribution inland from areas near the coast. Another conclusion that can be drawn from the historical records is that new populations of the weed have been established in many locations in Southern Norway during the last century. However, the fact that a real population growth and spread of the cockspur grass has been observed only in certain parts of the country, i.e. in the Oslo Fjord region, indicates that Norwegian environmental conditions (e.g. temperature and soil type) represent a border with respect to environmental requirements of the species.

3.2.1 Suitability of environment

According to CABI (2015), *Echinochloa crus-galli is* native to Eurasia and is widespread globally in warm temperate and subtropical regions, extending into the tropics (USDA-ARS, 2014). It prefers open sunny places and is largely restricted to wet soils, from loams to clays. It can tolerate drier soils, but can also continue to grow when partially submerged. It is found at altitudes of up to 2500 m and has a great cold tolerance due to the higher activity of a protective enzyme (FAO, 2014; Roy et al., 2000).

The information on climatic requirements of *E. crus-galli* covers general information on climate preferences for survival and a few studies on temperature requirements for seed germination of *E. crus-galli*. Open Learning Agency and British Columbia Ministry of Agriculture Food and Fisheries (2002) describes that *E. crus-galli* prefers climates with warm summer days and requires 160-200 days free from frost for survival. From two studies on temperature requirements for seed germination, it is concluded that *E. crus-galli* germinates over a wide temperature interval ranging from 13°C to 40°C, with an optimum temperature interval for germination ranging from 20°C to 30°C (Rahman and Ungar, 1990; Shipley and Parent, 1991).

However, Martinkova et al. (2006) found that the range of adequate temperatures increased with seed age. They reported that the common base temperature is 11.7°C. This means that old seeds will germinate at a lower temperature than fresh seeds, and thus be able to establish in relatively cold climate, although being a C_4 plant. Roy et al. (2000) found that cold-adapted North Canadian ecotypes of *E. crus-galli* originated from more southern American ecotypes and not from Europe. This could imply that cold-adapted North European *E. crus-galli* populations also could originate from southern ecotypes.

Interpretation of the information on temperature requirements for seed germination in the Norwegian context implies that Norwegian climates are sub-optimal for germination, as daily temperatures in the range from 20°C to 30°C are unusual. On the other hand, it would be interesting to know what temperature requirement *E. crus-galli* has for production of fertile seeds. The literature search has not revealed such information. However, some Norwegian investigations were carried out in climate chambers by Sjursen (1993). The experiment started with 2 ½ weeks old plants. At 15°C it took 70-75 days from start of the experiment till mature seeds. From seed emergence it consequently took 87-92 days. Number of days from seed emergence to mature seeds at 18°C and 21°C was 61 days. At 9°C and 12°C, the plants did not produce mature seeds even after 177 days. The information available on seed production and temperature is that heading begins about 40 days after emergence and that seeds mature about 20 days after heading. The maturation time will depend on temperature and there is information that the maturation process requires temperatures above 12°C. The observation done by Sjursen (1993) that seed maturation takes 87-92 days at 15°C, corresponds to an accumulated temperature sum between 261 – 276 degrees if the threshold temperature is set at 12°C. In another trial run at 20°C, it took 44 days, which corresponds to a temperature sum of 352 degrees above a threshold temperature of 12°C.

Based on this limited information it is still uncertain where to set the climatological limits for distribution in Norway. More information is needed on temperature needs for seed production.

Temperature is one of the main factors determining the distribution and productivity of C4 plants (Peiguo and Al-Khatib, 2003), and hence global warming could be expected to extend the distribution of *E. crus-galli* into cooler areas.

A study in Finland indicated that *E. crus-galli* is one of the weed species that most likely will benefit from the warmer climate and thereby expand its distribution (Hyvonen et al., 2010). In another study in Finland, Hyvonen and Ramula (2014) explored the impact of climate warming on establishment and persistence of *E. crus-galli* populations in the boreal region. The competition with a crop appeared to be more important for limiting the weed population than elevation in temperature (Hyvonen and Ramula, 2014). The weed was not able to maintain the population in competition with barley or maize. This report supports the findings of Vezina (1992) that *E. crus-galli* is a weak competitor to spring cereals.

3.2.2 Cultural practices and control measures

As mentioned in section 2.2, *E. crus-galli* is widely distributed in cereals and various vegetable crops in the two counties Østfold and Vestfold in Norway. It is assumed that the cultivation practises employed in these areas do not differ from practises employed elsewhere in the PRA area.

3.2.3 Other characteristics of the weed affecting the probability of establishment

Echinochloa crus-galli is an annual weed species of the family Poaceae. It proliferates by large seed production, and it is a notorious weed. *Echinochloa crus-galli* is a self-pollinated, hexaploid C_4 grass. It has an unusual plasticity with respect to its habitus. With sufficient space its straws grow close to the soil surface, while in dense stand it has an erect habitus. *Echinochloa crus-galli* is known for its high morphological variability (Damalas et al., 2008; Maun and Barrett, 1986).

Numerous studies found remarkable differences in sensitivity of *E. crus-galli* populations to herbicides, that cannot be attributed to treatment conditions (Damalas et al., 2008; De Cauwer et al., 2012; Vidotto et al., 2007). This has important consequences for weed control, as successful chemical weeding strategies rely on the knowledge of the weed response to herbicides (Damalas et al., 2008). Biotypes of *E. crus-galli* have expressed multiple herbicide resistance, both to acetyl CoA carboxylase (ACCase) inhibitors and to acetolactate synthase (ALS) inhibitors. The resistance mechanisms are likely to be non-target site based (multiple genes are involved in expression of the resistance), which implies a gradually build-up of resistance (Iwakami et al., 2015).

Echinochloa crus-galli is known to have strong allellopatic effect, by producing water-soluble phenolics harmful to adjacent weed plants and crops (Abbas et al., 2015a; Abbas et al., 2015b).

3.2.4 Conclusions on the probability of establishment

In conclusion, the probability of establishment of *E. crus-galli* in the PRA area is considered as likely. The uncertainty of this conclusion is low. (See rating scales for establishment and uncertainty in Appendix 2).

The overall assessment behind this conclusion is that the species is already established in parts of the risk assessment area.

3.3 Probability of spread

The process of spread of an organism (defined as expansion of its range within the PRA area) consists of:

(1) A movement of the organism over a certain distance, either by natural means or by human-mediated movement.
(2) Survival and reproduction at the new location to where it was spread.

From an ecological point of view, the processes of entry, re-entry, and spread, are really all about spread, independently of whether the species is crossing a country border or any administrative unit border. Whenever a species is moved, be it by natural or human assisted means, it needs to find suitable conditions at the new location, in order to survive and reproduce.

3.3.1 Identification of pathways for spread

Possible pathways for spread within the PRA area are:

- Relocation of soil
- Compost soil
- Seeds for planting
- Machinery
- Seeds from places for feeding birds
- Untreated manure and slaughterhouse waste used as fertiliser

Relocation of soil

The occurrence of *E. crus-galli* in a new lawn in Larvik in 2015 was most likely a result of contaminated soil. The lawn was produced on a soil mix (from several locations in Vestfold), and according to a preliminary report from Einar Kolstad, Larvik municipality, the soil was highly contaminated by *E. crus-galli* seeds. The Norwegian Nature Diversity Act (entered into

force on July 1st 2009) (Klima- og miljødepartementet, 2009) focuses on relocated soils as an important source for spread of invasive alien plant species. Enterprises responsible for projects, that include relocation of soil, are also responsible if alien species are spread because of their activity. An important part of the Regulation on wild oat (Landbruks- og matdepartementet, 2015) is to prohibit spread by moving soil from one location to another. Being aware that also the *E. crus-galli* seeds are quite dormant (Maun and Barrett, 1986), we assume that they may be spread by soil relocation.

Compost soil

When buried in compost, seeds of *E. crus-galli* were killed after a minimum of three days exposure to 49°C (Wiese et al., 1998). *Echinochloa crus-galli* seeds will not survive composting conditions according to the EPPO prescription for effective composting, which is either at least 55°C for a continuous period of two weeks, or at least 65°C for a continuous period of one week. It is important to rotate the windrow regularly (OEPP/EPPO, 2008).

Seeds for planting

Only a small percentage of the vegetable seeds used in Norway is produced in Norway. These are mainly sweedes, onion, and some other minor crops. No data are available on occurrence of *E. crus-galli* in Norwegian vegetable seeds.

Cereal seeds for planting are mainly produced in Norway, and in laboratory tests (purity) of certified Norwegian seeds, cockspur grass seeds have only been detected in a few seed lots of oat and wheat (table 2). Cockspur grass seeds were not detected in any seed lots of grasses and clover. During inspection of cereal seed production fields in the years 2012-2015, cockspur grass was reported from 22 fields (out of totally 2459 fields). In laboratory analyses of the seed lots harvested from these fields, the weed was recorded in only two of the lots.

Machinery

We have not found studies dedicated to evaluate spread by combine harvester. We assume, however, that an increase of the infested area within the field as well as contamination of new fields are inevitable, if infested areas are harvested and weed seeds enter the combiner. Harrowing and ploughing to some extent relocate soil within a field, and by doing so increase the infested area.

Seeds from places for feeding birds

Echinochloa crus-galli seeds finding their way to feeding places are assumed to be very likely. A further spread of *E. crus-galli* from the feeding places to agricultural fields is probably less likely to happen because a considerable part of the seeds are consumed by birds. However, as mentioned in section 3.1.2, the number of *E. crus-galli* seeds findings on waste deposits has increased during the last years. This indicates that *E. crus-galli*-

infestations on waste deposits could be a possible link between places for feeding birds to agricultural fields.

Untreated manure and slaughterhouse waste used as fertiliser

Fertilizing with liquid manure may contribute to spread of *E. crus-galli* in the field. Schröder and Baart (1982) found that *E. crus-galli* seeds remained viable after passing through the cattle intestine, but that ensilage for only 4-6 weeks resulted in complete loss of viability. Blackshaw and Rode (1991) found no viable *E. crus-galli* seeds after ensiling in a silo for 8 weeks or after rumen digestion for 24 hours.

3.3.2 Probability of the weed being associated with the pathway

Relocation of soil

Association of the weed to this pathway is considered as very likely, because relocation of soil frequently occurs in the PRA-area. There are no regulations or attention towards soil as a pathway for non-regulated weeds or plant pests. Spread of *E. crus-galli* by relocation of soil is documented, and this pathway is a general pathway for all kind of weeds. Massive relocation of soil commonly takes place e.g. in connection with road construction.

Compost soil

Association of the weed to this pathway is considered as unlikely given that the soil is composted according to standard procedures, achieving a sufficient duration of a temperature high enough to kill the weed seed.

Seeds for planting

Association of the weed to this pathway is considered as moderately likely because few incidents of contaminated seed lots are identified. During inspection of cereal seed production fields in the years 2012-2015, cockspur grass was reported from only 22 fields (out of totally 2459 fields), which can be taken as an indication that cereal seeds can be a potential pathway for spread. However, *E. crus-galli* seeds were detected only in two seed lots harvested from the 22 infested fields. During the years 2011-2015, *E. crus-galli* seeds were detected in seven cereal seed lots (five of oat, two of wheat).

Machinery

Association of the weed to this pathway is considered as likely because it is assumed that the weed easily attaches to machinery used for harvest, transport, harrowing and ploughing of infested areas. The same machinery is often used on several farms cowering wide areas, and is recognised as a general pathway for spread of weed seeds.

Seeds from places for feeding birds

Association of the weed to this pathway is considered as moderately likely. *Echinochloa crus-galli*-infestations on waste deposits could be a possible link between places for feeding birds to agricultural fields.

Untreated manure and slaughterhouse waste used as fertiliser

Association of the weed to this pathway is considered as unlikely because it does not seem to survive ensiling or rumen digestion of the fodder.

In summary

Table 7 summarises the probability of *E. crus-galli* to be associated with the identified pathways for spread.

Table 7: Assessment of the probability of the weed being associated with the pathways for spread identified in section 3.3.1.

Pathway for spread	Probability of association with pathway
Relocation of soil	Very likely Uncertainty: Low
Compost soil	Unlikely Uncertainty: High
Seeds for planting	Moderately likely Uncertainty: Medium
Machinery	Likely Uncertainty: Low
Seeds from places for feeding birds	Moderately likely Uncertainty: High
Untreated manure and slaughterhouse waste used as fertiliser	Unlikely Uncertainty: Medium

3.3.3 Conclusion on the probability of spread

In conclusion, the probability of spread of *E. crus-galli* within the PRA area is considered as likely. The uncertainty of this conclusion is low. (See rating scales for spread and uncertainty in Appendix 2).

The overall assessment behind this conclusion is that the weed has some non-specific pathways for spread, which occur in the risk assessment area (e.g. relocation of soil), no

effective barriers to spread exist, and suitable crops/habitats are widely present in some parts of the risk assessment area.

3.4 Conclusion on the probability of introduction and spread

During the 1970-ies and 1980-ies the supply of vegetable seeds was sometimes highly contaminated with *E. crus-galli* seeds. Imported vegetable seeds, especially carrot, were probably the origin of the heavy infestations of the well adapted biotypes in Østfold and Vestfold counties today. Currently, more effective herbicides are likely to be used in the seed-producing countries. The seed cleaning procedures and the quality of the production line have presumably improved since the mid-nineties. In addition, vegetable seed are often pelleted. Therefore, imported and Norwegian vegetable seeds are not regarded as a pathway for entry or spread today.

Currently, among the three relevant pathways for entry, bird seeds are considered as most important. This pathway, however, is not likely to reach agricultural land directly, but depends on spread from places for feeding birds, possibly via infestations of waste deposits. Among the four pathways identified as relevant for spread, relocation of soil and machinery are the most important. Both these pathways, and also seeds for planting, can spread the weed directly to agricultural fields. In conclusion, spread within the PRA area might be more likely than establishment from new entries of *E. crus-galli*.

3.4.1 Conclusion regarding endangered areas

Echinochloa crus-galli is a summer annual plant, and it is hence dependent on arable cropping to survive. Therefore, and due to the fact that cockspur grass populations have been able to establish from Aust-Agder County in south to Hedmark County in north, all arable land in low altitudes of South Eastern Norway is considered as endangered area. The total area currently infested is roughly estimated to represent less than half of the endangered area.

4 Assessment of impact

4.1 Weed effects

Weeds compete with the crops for water, nutrients and light. This competition results in yield losses, and sometimes also reduction in crop quality. The size of these losses depends on the amount of weeds in the field, but equally or more important is the competitiveness of the crop and other weed species present in the flora. Losses will influence the farmer's income directly (e.g. crop and quality loss) and indirectly (e.g. higher production costs due increased weed management). Also, the society in general will in the long run be affected, if the agriculture branch produces less commodities, or to a higher cost than expected.

4.1.1 Direct weed effects

Echinochloa crus-galli has the capability to reduce crop yields and cause forage crops to fail by removing up to 80% of the available soil nitrogen (Holm et al., 1977). *Echinochloa crus-galli* is considered the world's worst weed in rice and has also been listed as a weed in at least 36 other crops throughout tropical and temperate regions of the world (Holm et al., 1977), e.g. maize, soya bean, lucerne, vegetables, root crops, orchards and vineyards

In their data sheet on *E. crus-galli*, CABI (2015) refers to several studies on crop losses, which varies from 6% to 97%. Most of these studies were on crops that are not grown, or not grown outdoors in Norway. Several of the studies were on maize, which is only grown to a limited extent in Norway.

When it comes to crops that are important to Norwegian agriculture, there are only a few studies on yield losses caused by *E. crus-galli* in potato, spring wheat and barley. In Poland, an infestation of 4-8 *E. crus-galli* plants per $10m^2$ caused 11% yield reduction in potato (Ratajczyk, 1993). In the USA, Vangessel and Renner (1990) showed that losses in potato depended on whether the weed was growing in the rows or between them. In two successive years, losses from infestations within the row were about 20, 30 and 40% from infestations of 1, 2 and 4 *E. crus-galli* plants/m of row, but the losses were negligible when the same numbers of weed plants occurred between the rows.

In a Canadian field trial in spring wheat and barley no significant yield losses were found, even at high weed density (Vezina, 1992). Hyvonen and Ramula (2014) claimed, based on modelling, that in the boreal region *E. crus-galli* was not able to compete with barley. In Denmark, *E. crus-galli* is mostly found in row-seeded crops, such as maize, where it is easily established due to late sowing and the poor competition from maize early in the growing season (Mathiassen and Kudsk, 2004). The weed is sometimes found in cereal fields, but it is not considered a problem in cereals. However, some spread within Christmas tree plantations has been found (personal communication, Peter Hartvig, Århus University). In

Finland, there are no reports of this weed in any of the main crops, except for potato, where there are a few reports and the area infested is stable. Finland does not regard *E. crus-galli* as a challenge when it comes to weed control (see Appendix 4). In Sweden, there are few reports of infestations in spring cereals and vegetables. However, the infested area is increasing, and the weed is regarded as a challenge (see Appendix 4), and Andersson (2011) reported *E. crus-galli* to be frequently found in maize and sugar beet in Sweden.

Surveys from the counties of Østfold and Vestfold in Norway, show that *E. crus-galli* establishes well in spring cereal crops. Local extension service officers and farmers claim that they experience difficulties in controlling the weed, and it seems to spread even further north in Norway. Infested fields are reported from areas north of 60th latitude. In a field trial in spring wheat carried out by NIBIO and the Norwegian Agricultural Extension Service Viken, effective herbicides applied at the right time increased yield by 20% compared to untreated control. The herbicide application reduced the number of *E. crus-galli* plants at harvest from 51 plants per m^2 on untreated control to three to five plants per m^2 after the most effective herbicide treatments (Norwegian Agricultural Extension Service Viken, 2014).

Yield losses in less competitive vegetable crops, due to uncontrolled *E. crus-galli* infestations, will be much higher. In several herbicide efficacy field trials carried out at Rygge municipality, Østfold County, by NIBIO and the Norwegian Agricultural Extension Service, vegetable crops were frequently destroyed by *E. crus-galli* on the untreated control plots (unpublished data, Jan Netland, NIBIO). Siri Abrahamsen, the Norwegian Agricultural Extension Service Viken, states that potato crops compete quite well with *E. crus-galli* and that the weed is not regarded as a major problem (Berntsen, 2015).

4.1.2 Indirect weed effects

In cereals an *E. crus-galli* infestation, which is not controlled by hand roughing immediately after establishment, has to be sprayed with herbicides to avoid further spread. In vegetable crops, mechanical hoeing is an option, but in conventional/integrated weed management, herbicide may be applied. There are effective herbicides or gramicides (controls grasses) available on the market, but *E. crus-galli* in the weed flora means an extra herbicide application, which is expensive and an extra load on the environment.

With an average yield of 6 tons spring wheat per ha, a 20 % yield loss is 1200 kg per ha. This loss represents an income reduction of NOK 2520 per ha for the farmer. The most effective chemical treatments against the weed are 1.0 litre of Axial at a cost of NOK 397 per ha, or 1.4 litres of Puma Extra at a cost of NOK 352 per ha (personal communication, Felleskjøpet Agri). These herbicides cannot be used in oat. This restricts the cultivation of oat in cereal mono cropping, which is very common in Norway. Abrahamsen et al. (2016) found that the value of oat in the rotation is +660 kg wheat per ha compared to wheat after wheat with yield of 4290 kg per ha. This represent a loss in income of NOK 1980 per ha for the farmer.

Echinochloa crus-galli populations carry a high potential for herbicide resistance development, due to their genetic variability, fecundity and seed longevity (Vencill et al., 2014).

The most common herbicides for control of *E. crus-galli*, both in cereals, vegetables, oil seed and potato, belong to the group acetyl-CoA carboxylase (ACCase) inhibitors. That implies a high risk for ACCase resistance development in an arable rotation containing these crops. Acetolactate synthase (ALS) inhibitors is another important group of herbicides, extensively use in weed control in cereals. Herbicides in this group have already developed resistant weeds in cereals in Norway (Netland and Wærnhus, 2007). Another weed controlled with the same group of herbicides would increase selection pressure for resistant biotypes. Herbicide resistance complicates weed control, and makes it more expensive.

Farmers producing cereal and grass seed on contract can lose income if *E. crus-galli* is found in their fields. In some cases fallowing or establishing a grass ley on the infested area are the only options. Fallow is not a recommended method for control of annual weeds with dormant seed, because it takes long time to empty the seedbank. In organic farming it is not allowed to use herbicides, and *E. crus-galli* is difficult to control.

In addition to losses of crop yield and quality, and additional weed control costs, *E. crus-galli* is an alternative host to a wide range of crop pests (CABI, 2015).

4.1.3 Environmental impact

According to CABI's data sheet on the species (CABI, 2015), *E. crus-galli* grows as a weed of waterways, swamps, wetlands and other damp habitats, as well as a weed in cultivated vegetables and cereal crops, on roadsides, waste areas and disturbed land sites. The weed may be altering successional processes and outcompete native vegetation. *Echinochloa crus-galli* has been listed as an environmental weed in Canada, the United States, Brazil and Australia, where it is ranked among the top 200 most invasive plant species.

The Norwegian Biodiversity Information Centre, on the other hand, concludes that *E. crus-galli* does not invade less managed nature types, and it is not expected to do so in the future (Artsdatabanken, 2016).

4.2 Conclusion of the assessment of impact

There are only a limited numbers of scientific reports on yield responses due to competition with *E. crus-galli* in barley, wheat and oat. The two reports, both from Northern countries (Canada and Finland) indicate that effect of competition is not significant. Monitoring from the counties Østfold and Vestfold in Norway, on the other hand, shows that *E. crus-galli* establishes well in spring cereal crops. Local extension service officers and farmers claim that they experience difficulties in controlling the weed, and it seems to spread even further north in Norway. Infested fields are reported from areas north of 60th latitude. It is likely that the

conditions in arable farming are better for a species with high temperature demand, like *E. crus-galli*, in the southern part of the country, than further north. Climate change may enhance the progress of northward spread.

Direct and indirect effect of the weed will have economic consequences for farmers and in the long run also for the society.

In conclusion, we assess the economic consequences of *E. crus-galli*-infestation of crops to be major in cereals and potato and massive in vegetable. The uncertainty behind this assessment is high. (See rating scales for consequences and for uncertainty in appendix 2).

The overall assessment behind this conclusion is that

- In *E. crus-galli*-infested cereal or potato crops the yield is frequently significantly reduced and additional control measures are frequently necessary.
- In *E. crus-galli*-infested vegetable crops, crop production is always or almost always reduced to a very significant extent (severe crop losses that compromise the harvest) and additional control measures are always necessary.

5 Identification and evaluation of risk reduction options

5.1.1 Risk reduction options to prevent entry

To prevent entry from other countries into the PRA-area, it is important to avoid import of contaminated seeds for planting. *Echinochloa crus-galli* is, to our knowledge, not regulated in the exporting countries, from where Norway import seeds for planting. However, similar requirements for inspection and prohibitions concerning import of seeds lots as for wild oat would reduce the possibility for entry of *E. crus-galli*.

Since bird seed imported to Norway is inspected for occurrence of wild oat and hemp, similar requirements can easily be implemented for cockspur grass seed. This would reduce new entry of the weed.

The use of seed-killing herbicides to the soil of ornamental plants rooted in containers with soil would reduce the germination of *E. crus-galli* seeds from contaminated soil.

5.1.2 Risk reduction options to prevent establishment and damage to crop

5.1.2.1 Chemical control

During recent decades, effective herbicides for control of grass weeds, including *E. crus-galli* have been developed. Most crops are sprayed with selective herbicides, which mean that they can be applied on growing crops without harming the crop. Table 8 shows available herbicide in different crops in Norway.

The herbicides have been proved to be very effective in most crops. However, if the cereal crop gets too high before the cockspur grass germinates, the herbicide may fail to reach the weed and the effect will be limited. This situation also makes it difficult to find optimal time for the herbicide application (Berntsen 2015).

The efficiency of herbicide use depends on no development of herbicide resistance. Biotypes of *E. crus-galli* have expressed multiple herbicide resistance; both to acetyl CoA carboxylase (ACCase) inhibitors and to acetolactate synthase (ALS) inhibitors (see section 3.2.3).

Table 8: Overview of approved herbicides in Norway for control *E. crus-galli.* If a weed is resistant against one herbicide, the species is likely to have resistance also against other active ingredients with the same mode of action.

Trade name	**Focus ultra**	**Select**	**Agil**	**Puma Extra**	**Axial**	**Attribut Twin**	**Titus**
Active ingredient	cyclo-xydim	cletho-dim	propa-quizafop	fenoxa-prop	pinoxa-den	propoxy-carbazone + iodosulfuron	rimsul-furon
Mode of action	ACCase inhibitors					ALS inhibitors	
Crop							
Wheat, barley				X	X	X[1]	
Oat							
Potato	X	X	X				X
Cabbage, celery	X		X				
Oil seed rape, turnip rape, peas, carrots, onions,	X	X	X				

X=approved; X[1]=approved only in wheat

5.1.2.2 Cultural control

Weed harrowing is the only mechanical option in cereals. *Echinochloa crus-galli* is a challenge because of late germination and the wide time span in germination intervals, compared to the crop and the other weeds present. In most springs, the cereals and additional weeds will grow too tall for blind harrowing before the cockspur grass germinates. In any case this needs to be tested before recommendation.

Row hoeing: In potato and vegetables with broad row distance, hoeing is an option. For this method the late germination is actually an advantage, because of the size difference between the weed and the crop means that it is possible to run the machinery at a relatively high speed through the fields.

In important crops, the farmers may control small infestations by systematically walking through the fields to eradicate the weed by hand.

5.1.2.3 Integrated control

Echinochloa crus-galli is an annual species, and it is dependent on arable cropping to expand. In areas with widespread arable land and repeated cereal rotations the environment for spread is favourable. Grass leys in rotation with arable crops will limit the expansion of *E. crus-galli* and also prevent or delay new establishment. A normal length of the ley period of 3-4 year will probably be sufficient to keep the infestation under control. Too little is known about seed dormancy of the Norwegian biotypes to give qualified advice about length of the ley period. In fields with high weed infestation and where herbicides cannot be used to control it (e.g. in organic farming), conversion to grass production on the

area is an option. The ley needs to be permanent for some years to achieve a substantial reduction of the seed bank, but more exactly how long is not known.

Winter cereal cropping may limit infestations with *E. crus-galli*, because *E. crus-galli* plants from seeds that germinate in the autumn will be killed during winter. *Echinochloa crus-galli* plants that germinate in spring will probably meet hard competition from the already established cereal crop (Sjursen, 1993). High frequency of grass ley in the rotation is an important limiting environmental factor for *E. crus-galli* establishment. This is especially important for organic farming.

Traditional fallow is not a good option, because it will take too long to empty the seed bank. The process will in addition be very costly.

Echinochloa crus-galli is a good grazing grass, and heavily infested fields may be used as pasture.

In its data sheet on *E. crus-galli*, CABI (2015) referred to several studies on the effect of a variety of biological control agents.

5.1.3 Risk reduction options to prevent further spread

To prevent further spread within the PRA-area it is important to avoid contaminated seeds for planting. *Echinochloa crus-galli* is not regulated in Norway, but production areas for seeds for planting are regularly inspected to control wild oat. Many cereal farmers carry out the same measure on their fields. These inspections could also include *E. crus-galli*, if this weed may be detected at the same time as wild oat. However, due to the expected relatively high temperature demand for germination (see 3.2.1), late-germinating individuals may not reach the cereal canopy, and they may, therefore, not be spotted during the wild oat inspection. The soil temperature demand for germination of adapted Norwegian *E. crus-galli* biotypes is not well documented. If this data gap is filled, an optimal inspection period could be predicted.

It is important that geographic coordinates are given for all infestations (GPS-tagging), so that small patches with *E. crus-galli* can be followed up by hand weeding. It would be helpful if *E. crus-galli* was included in already existing inspections to control wild oat in Norwegian production of seeds for planting.

The risk of further spread of *E. crus-galli* could be reduced significantly if relocation of soil from *E. crus-galli*-infested area was restricted in the same way as soil infested by wild oat and invasive alien species. This includes also soil from waste deposits and mills because *E. crus-galli* often is found there. The risk will also be reduced if *E. crus-galli*-contaminated bio-waste is carried out in a safe way before it is dispersed.

Weed seeds are dispersed within a field and from a field to another by machinery. In particular combine harvesters may carry *E. crus-galli* seeds over long distances if not

properly cleaned when leaving an infested field. This may be avoided by good cleaning procedures.

6 Uncertainties

In the following text of this chapter, all the uncertainties that have been identified in the different steps of the current opinion are presented for each chapter of the opinion.

Occurrence in the PRA-area

Some uncertainty is due to the fact that none of the counties cowered by VKM's inquiry for expert opinions about the status of *E. crus-galli* infestation had carried out any kind of monitoring in the district they represented. In addition, not all parts of the counties were covered by the experts we consulted. This is also the case where monitoring actually have been carried out (Vestfold County and the municipality of Fredrikstad in Østfold County). Several of the field records of *E. crus-galli* available from the Norwegian Biodiversity Information Centre (Artsdatabanken, 2015) may be single plants, and it is not checked, whether there is an established infestations or not. When agricultural experts from the actual area are consulted, they have no reports of established *E. crus-galli* e.g. in Nord-Trøndelag see table 1.

Uncertainties concerning introduction and spread (Chapter 3)

Entry from other countries into the PRA area

The main uncertainty is the lack of documentation of entry, due to the fact that *E. crus-galli* is not a regulated species. The few samples of imported bird seed that have been analyzed, have not been collected in a systematic way, and they do not give a representative picture of the situation. Frequently, the seed-producing country is difficult to track and information on the origin of the bird seeds is not available.

Spread after establishment

The potential for spread has low uncertainty, but the ranking of the different pathways has high uncertainty. Some information is missing, when it comes to assessing the possibility for the weed seed to be transported to suitable agricultural land. It is known that the seeds readily reach waste deposits. If the waste is not composted, or composted at too low temperature and disposed on arable land, a new infestation may be initiated. This chain of events is not documented.

Endangered area:

Low altitude areas of south eastern Norway, from Hedmark County in the north to Vest-Agder County in the south, are defined as endangered areas. This conclusion is based on information of two infested fields in the northern part of the endangered area, and the assumption that these fields are representative for the area between the northern border

and southward to the core infestation area in the counties of Østfold, Vestfold and south-eastern part of Buskerud.

Uncertainties concerning impact (Chapter 4)

The documentation of yield losses due to competition with *E. crus-galli* under Norwegian conditions is very limited. *Echinochloa crus-galli* is considered to be very competitive to vegetables and in Norway even to spring cereals. However, according to the two studies in spring cereals (Hyvonen and Ramula, 2014); Vezina (1992), both spring wheat and barley compete well with *E. crus-galli.* Before it can be documented to what extent the Norwegian *E. crus-galli* biotypes are competitive, there will be high uncertainty regarding economic consequences in cereals and potato.

7 Conclusions (with answers to the terms of reference)

7.1 Current distribution in Norway

The core distribution areas for *E. crus-galli* in Norway are the two counties Vestfold and Østfold. The high number of infestations on agricultural land in these two counties is regarded as a threat by the farmers and the current occurrence has reached a level adding significantly to the weed control burden. A systematic and country-wide survey of such areas is missing, but an indication of the magnitude of the distribution on agricultural land is reported from the Municipal and County Agricultural Offices, from the Norwegian Agricultural Extension Service and from the field inspection of cereal seed production. In addition to severe infestations in Larvik and Fredrikstad, the weed is also confirmed to be established in the municipalities of Lardal, Sandefjord and Stokke in Vestfold County, in Rygge, Sarpsborg and Halden municipalities in Østfold County, and in the municipalities of Øvre Eiker, Nedre Eiker, Kongsberg and Modum in Buskerud County. Over all, this area can be regarded as a more or less continuously infested area. However, the occurrence of *E. crus-galli* also shows signs of spread beyond this area. Reports of infested fields come from Ullensaker and Ås municipalities in Akershus County, Bø municipality in Telemark County, Grimstad municipality in Aust-Agder County and Ringsaker and Åsnes municipalities of Hedmark County. According to these reports, establishment of *E. crus-galli* north of the 60 degrees latitude is confirmed.

7.2 Pathways for entry and spread

During the 1970-ies and 1980-ies the supply of vegetable seeds was sometimes highly contaminated with *E. crus-galli* seeds. Imported vegetable seeds, especially carrot, were probably the origin of the heavy infestations of the well adapted biotypes in Østfold and Vestfold counties today. Currently, more effective herbicides are likely to be used in the seed-producing countries. The seed cleaning procedures and the quality of the production line have presumably improved since the mid-nineties. In addition, vegetable seed are often pelleted. Therefore, imported and Norwegian vegetable seeds are not regarded as a pathway for entry or spread today.

Currently, there are three pathways identified as relevant for entry of cockspur grass into the PRA area. Below they are ranked by their relative importance:

1. Bird seeds.
2. Ornamental plants rooted in soil.
3. Grass and legume seeds for planting.

It is very likely, with a low uncertainty, that the weed is associated with imported bird seeds. The import volume is high, and there are some data on occasional observations of *E. crus-galli* seeds in imported bird seeds. Also, in Asia and Africa *E. crus-galli* is produced to a certain extent as bird feed. A possible pathway from places for feeding birds to agricultural fields could be via garbage deposits. The probability of association with ornamental plants rooted in soil is considered as moderately likely, with a medium uncertainty. Although the *E. crus-galli* seed has not been found in recent years in imported grass and legume seeds, it might be a pathway if seeds of these species are imported from countries were the weed occurs abundantly. The probability of association with imported grass and legume seeds is considered as moderately likely, with a high uncertainty.

Currently, vegetable seeds for planting, cereal seeds for planting, and growth media are all evaluated as not relevant pathways as the association of the weed is considered as unlikely. The uncertainty of this conclusion is medium. For more details, see section 3.1.

There are four pathways identified as relevant for spread of cockspur grass within the PRA area. Below they are ranked by their relative importance:

1. Relocation of soil
2. Machinery
3. Seeds for planting
4. Seeds from places for feeding birds

It is very likely, with a low uncertainty, that the weed is associated with relocation of soil, because relocation of soil frequently occurs in the PRA-area. There are no regulations or attention towards soil as a pathway for non-regulated weeds or plant pests. Spread of *E. crus-galli* by relocation of soil is documented, and this pathway is a general pathway for all kind of weeds. Massive relocation of soil commonly takes place e.g. in connection with road construction. The probability of association with machinery is considered as likely because it is assumed that the weed easily attaches to machinery used for harvest, transport, harrowing and ploughing of infested areas. The same machinery is often used on several farms cowering wide areas, and is recognized as a general pathway for spread of weed seeds. In addition, association of the weed with the two pathways seeds for planting and seeds from places for feeding birds are both considered as moderately likely.

Compost soil and untreated manure and slaughterhouse waste used as fertilizer were both evaluated as not relevant pathways as the association of the weed is considered as unlikely. The uncertainty of this conclusion is medium. For more details, see section 3.3.

The most important pathways for entry, bird seeds, is not likely to reach agricultural land directly, but depends on spread from places for feeding birds, possibly via infestations of waste deposits. When it comes to pathways for spread, both relocation of soil and machinery, the two most important pathways, and also seeds for planting, can spread the weed directly to agricultural fields. Therefore, spread within the PRA area might be more likely than establishment from new entries of *E. crus-galli*.

7.3 Potential of establishment and further spread in Norway

In terms of reference, we are asked to assess the potential of further spread and establishment of the weed in Norwegian agriculture, including information about possible connections between spread and establishment of the plant, and the production method (crop, technique of cultivation etc.).

The probability of establishment of *E. crus-galli* in the PRA area is considered as likely. The uncertainty of this conclusion is low. The overall assessment behind this conclusion is that the species is already established in parts of the risk assessment area.

The probability of spread of *E. crus-galli* within the PRA area is considered as likely. The uncertainty of this conclusion is low. The overall assessment behind this conclusion is that the weed has some non-specific pathways for spread, which occur in the risk assessment area (e.g. relocation of soil), no effective barriers to spread exist, and suitable crops/habitats are widely present in some parts of the risk assessment area.

Climate change may enhance the progress of northward spread.

Echinochloa crus-galli is a summer annual plant, and it is hence dependent on arable cropping to survive. Therefore, and due to the fact that cockspur grass populations have been able to establish from Aust-Agder County in south to Hedmark County in north, all arable land in low altitudes of South Eastern Norway is considered as endangered area. The total area currently infested is roughly estimated to represent less than half of the endangered area.

For information about possible connections between spread and establishment of the plant and the production method (crop, technique of cultivation etc.), see chapter 5 about risk reduction options.

7.4 Potential for impact in Norway

In terms of reference, we are asked to assess the potential of harmful effects in Norway (crop reductions, decrease of quality, the need for plant protection products etc.).

In conclusion, we assess the economic consequences of *E. crus-galli*-infestation of crops to be major in cereals and potato and massive in vegetable. The uncertainty behind this assessment is high. (See rating scales for consequences and for uncertainty in appendix 2).

The overall assessment behind this conclusion is that

- In *E. crus-galli*-infested cereal or potato crops the yield is frequently significantly reduced and additional control measures are frequently necessary.

- In *E. crus-galli*-infested vegetable crops, crop production is always or almost always reduced to a very significant extent (severe crop losses that compromise the harvest) and additional control measures are always necessary.

Vegetables are not able to compete with *E. crus-galli*. If the crop is not treated with herbicides at the right time the yield loss may be total.

In spring wheat, the yield loss may be 20 % or more in infested fields, if not effective control measures are applied. Very little documentation of yield losses in cereals exists. In general, the earlier the weed germinates compared to the crop, the higher yield loss may be expected. *Echinochloa crus-galli* has high temperature demand for germination compared to cereals. In cold springs the cereals compete better with this weed than in warm springs. Potato crops are also vulnerable in competition with this weed, however less vulnerable than vegetables.

There are effective herbicides for control of *E. crus-galli* in most crops, apart from oat. Hence it may be risky to grow oat in fields infested by *E. crus-galli*. In mono cropping of cereals, oat is important in the rotation, because the crop is resistant to most diseases in wheat and barley. Thus, the economic consequences of *E. crus-galli* can be considerable.

In barley and wheat two herbicide applications may be necessary, due to the long germination period of *E. crus-galli* seeds. The standard in spring cereals today is only one herbicide application per year. In addition, the herbicides most effective in control of *E. crus-galli* are more expensive than the commonly applied herbicides in cereals.

7.5 Identification and evaluation of risk reduction options

In terms of reference, we are asked to identify and evaluate possible effective measures to prevent further spread and establishment, or to reduce harmful effect to the agriculture in Norway. If relevant, experiences in other countries should be pointed out.

Risk reduction options are evaluated in chapter 5. Some of these measures might be achieved through intensified information to farmers, enterprises for gardens and road constructors, the authority, the Norwegian Agricultural Extension Service, and other stakeholders. Some of the measures might be achieved through already existing regulations, or by implementing new regulations.

8 Data gaps

In this chapter (table 9), insufficient knowledge and/or data related to the topic covered in the risk assessment is described. All data gaps described was uncovered during the risk assessment process.

Table 9: Knowledge and/or data uncovered in the current risk assessment and consequences if the knowledge and data are provided.

Data gaps	**Consequences if data gaps are filled** **(for VKM, the assigner, and/or the society)**
Systematic survey of occurrence of *E. crus-galli* in Norway is missing. The method of site-referenced infestations applied in Vestfold could be copied.	With site-referenced infestations of the weed, precautions can effectively be taken to avoid spread e.g. by machinery and relocation of soil. This would be very helpful for farmers renting agricultural land and using their machines over large areas. A systematic mapping would also be very useful when identifying and evaluating the importance of pathways for spread.
There is lack of data on contamination with viable seeds in the different steps of the identified pathways for spread	Such data are necessary to range the relative importance of the suggested pathways for spread of *E. crus-galli*. This knowledge would help the Norwegian Food Safety Authority to decide if, and to identify which, regulations would be appropriate to implement. For the farmers' community, successful regulations would contribute to less laborious and less costly crop protection. This will in the long run also serve the society.
There is some lack of knowledge on the biology and temperature requirements of Norwegian biotypes of *E. crus-galli*. Biology includes germination, early growth and seed production	With more knowledge on this subject, it would be possible to decide which features seem to make the Norwegian biotypes more expanding and competitive in cereals compared to reports from other Nordic countries. With data on temperature requirements, optimal timing of inspection and control measure may be predicted
Empirical data on the perceived extraordinarily wide germination period of *E. crus-galli* is missing. Knowledge on how the timing of the germination of the weed relative to the germination of the crop affects the yield is also missing.	With this data, models predicting the optimal timing of herbicide application could be established and made available on the web-based decision support system VIPS (NIBIO and Norsk Landbruksrådgiving, 2016). Such models enable a more targeted timing of spraying, resulting in less herbicide use without reducing efficacy and yield.
Yield effects under Norwegian or Nordic conditions in crops relevant to Norway	Such data is necessary to give a more certain evaluation of the impact of the weed on yield in Norway

Data gaps	Consequences if data gaps are filled (for VKM, the assigner, and/or the society)
Data on how herbicide efficacy varies with growing conditions.	With such data recommendation for more targeted timing of spraying will be given, resulting in less herbicide use without reducing efficacy
Population dynamic in different soils and under different tillage practices	With such data recommendation for controlling severe infestation may be improved

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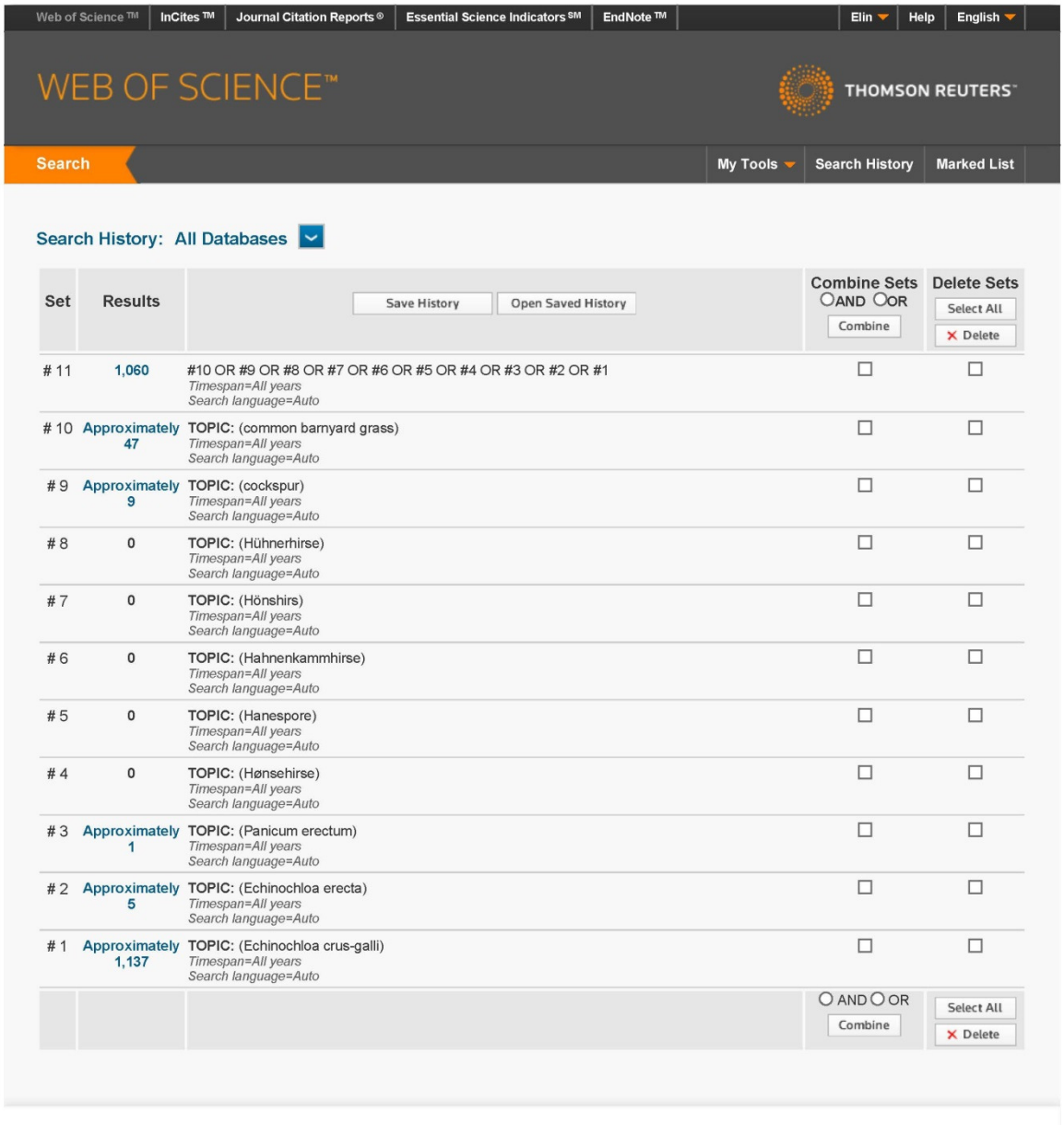
Appendix 1

Literature search strategy



Web of Science ™ | InCites ™ | Journal Citation Reports ® | Essential Science Indicators SM | EndNote ™ | Elin | Help | English

WEB OF SCIENCE™ — THOMSON REUTERS

Search | My Tools | Search History | Marked List

Search History: All Databases

Set	Results	Save History / Open Saved History	Combine Sets (AND / OR) Combine	Delete Sets Select All / Delete
# 11	1,060	#10 OR #9 OR #8 OR #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1 *Timespan=All years* *Search language=Auto*	☐	☐
# 10	Approximately 47	TOPIC: (common barnyard grass) *Timespan=All years* *Search language=Auto*	☐	☐
# 9	Approximately 9	TOPIC: (cockspur) *Timespan=All years* *Search language=Auto*	☐	☐
# 8	0	TOPIC: (Hühnerhirse) *Timespan=All years* *Search language=Auto*	☐	☐
# 7	0	TOPIC: (Hönshirs) *Timespan=All years* *Search language=Auto*	☐	☐
# 6	0	TOPIC: (Hahnenkammhirse) *Timespan=All years* *Search language=Auto*	☐	☐
# 5	0	TOPIC: (Hanespore) *Timespan=All years* *Search language=Auto*	☐	☐
# 4	0	TOPIC: (Hønsehirse) *Timespan=All years* *Search language=Auto*	☐	☐
# 3	Approximately 1	TOPIC: (Panicum erectum) *Timespan=All years* *Search language=Auto*	☐	☐
# 2	Approximately 5	TOPIC: (Echinochloa erecta) *Timespan=All years* *Search language=Auto*	☐	☐
# 1	Approximately 1,137	TOPIC: (Echinochloa crus-galli) *Timespan=All years* *Search language=Auto*	☐	☐
			AND / OR Combine	Select All / Delete

Appendix 2

Ratings and descriptors

Ratings and descriptors are based on Appendix E in EFSA's Scientific Opinion on the risks to plant health posed by *Xylella fastidiosa* in the EU territory (EFSA Panel on Plant Health, 2015).

Table A2-1: Rating of probability of entry from other countries outside the PRA area to a suitable habitat within the PRA area

Rating	Descriptors
Very unlikely	The likelihood of entry would be very low because the weed: • is not, or is only very rarely, associated with the pathway at the origin, • may not survive during transport or storage, • cannot survive the current pest management procedures existing in the risk assessment area, • may not transfer to a suitable habitat in the risk assessment area.
Unlikely	The likelihood of entry would be low because the weed: • is rarely associated with the pathway at the origin, • survives at a very low rate during transport or storage, • is strongly limited by the current pest management procedures existing in the risk assessment area, • has considerable limitations for transfer to a suitable habitat/crop in the risk assessment area.
Moderately likely	The likelihood of entry would be moderate because the weed: • is frequently associated with the pathway at the origin, • survives at a low rate during transport or storage, • is affected by the current pest management procedures existing in the risk assessment area,

	• has some limitations for transfer to a suitable habitat/crop in the risk assessment area.
Likely	The likelihood of entry would be high because the weed: • is regularly associated with the pathway at the origin, • mostly survives during transport or storage; • is partially affected by the current pest management procedures existing in the risk assessment area, • has very few limitations for transfer to a suitable habitat/crop in the risk assessment area.
Very likely	The likelihood of entry would be very high because the weed: • is usually associated with the pathway at the origin, • survives during transport or storage; • is not affected by the current pest management procedures existing in the risk assessment area, • has no limitations for transfer to a suitable habitat/crop in the risk assessment area.

Table A2-2: Rating of the probability of establishment

Rating	**Descriptors**
Very unlikely	The likelihood of establishment would be very low because: • of the absence or very limited availability of suitable habitat/crop; • the unsuitable environmental conditions; • and the occurrence of other considerable obstacles preventing establishment
Unlikely	The likelihood of establishment would be low because: • of the limited availability of suitable habitat/crop; • the unsuitable environmental conditions over the majority of the risk assessment area; • the occurrence of other obstacles preventing establishment

Moderately likely	The likelihood of establishment would be moderate because: • suitable habitats/crops are abundant in few areas of the risk assessment area; • environmental conditions are suitable in few areas of the risk assessment area; • no obstacles to establishment occur
Likely	The likelihood of establishment would be high because: • suitable habitats/crops are widely distributed in some areas of the risk assessment area; • environmental conditions are suitable in some areas of the risk assessment area; • no obstacles to establishment occur. • Alternatively, the weed has already established in some areas of the risk assessment area
Very likely	The likelihood of establishment would be very high because: • hosts plants are widely distributed; • environmental conditions are suitable over the majority of the risk assessment area; • no obstacles to establishment occur. • Alternatively, the weed has already established in the risk assessment area

Table A2-3: Rating of the probability of spread

Rating	Descriptors
Very unlikely	The likelihood of spread would be very low because: • the weed has only one specific way to spread (e.g. a specific vector) which is not present in the risk assessment area; • highly effective barriers to spread exist; • the suitable habitats/crops are not or very rarely present in the area of possible spread
Unlikely	The likelihood of spread would be low because: • the weed has one to few specific ways to spread and the occurrence of the weed in the risk

	assessment area is rare; • effective barriers to spread exist; • the suitable habitats/crops are occasionally present
Moderately likely	The likelihood of spread would be moderate because: • the weed has few specific ways to spread (e.g. specific vectors) and the occurrence of the weed in the risk assessment area is limited; • partially effective barriers to spread exist; • the suitable habitats/crops are abundant in few parts of the risk assessment area
Likely	The likelihood of spread would be high because: • the weed has some non-specific ways to spread (e.g. mechanical transmission), which occur in the risk assessment area; • no effective barriers to spread exist; • the suitable habitats/crops are widely present in some parts of the risk assessment area
Very likely	The likelihood of spread would be very high because: • the weed has multiple non-specific ways to spread (e.g. mechanical transmission), which all occur in the risk assessment area; • no effective barriers to spread exist; • the suitable habitats/crops are widely present in the whole risk assessment area

Table A2-4: Rating of the assessment of impact to the agriculture (economic consequences)

Rating	Descriptors
Minimal	Differences in crop production (saleable cereals, vegetables, tubers, plants for planting, seed, etc.) are within normal day-to-day variation; no additional control measures are required
Minor	Crop production (saleable cereals, vegetables, tubers, plants for planting, seed, etc.) is rarely reduced or at a limited level; additional control measures are rarely necessary

Moderate	Crop production (saleable cereals, vegetables, plants for planting, seed, etc.) is occasionally reduced to a limited extent; additional control measures are occasionally necessary
Major	Crop production (saleable cereals, vegetables, tubers, plants for planting, seed, etc.) is frequently reduced to a significant extent; additional control measures are frequently necessary
Massive	Crop production (saleable cereals, vegetables, tubers, plants for planting, seed, etc.) is always or almost always reduced to a very significant extent (severe crop losses that compromise the harvest); additional control measures are always necessary

Table A2-5: Ratings used for describing the level of uncertainty

Rating	Descriptors
Low	No or little information or no or few data are missing, incomplete, inconsistent or conflicting. No subjective judgement is introduced. No unpublished data are used.
Medium	Some information is missing or some data are missing, incomplete, inconsistent or conflicting. Subjective judgement is introduced with supporting evidence. Unpublished data are sometimes used.
High	Most information is missing or most data are missing, incomplete, inconsistent or conflicting. Subjective judgement may be introduced without supporting evidence. Unpublished data are frequently used.

Appendix 3

Questions regarding occurrence of *Echinochloa crus-galli* in Norway.

Identical questionnaires in Norwegian were sent to the County Governor (Fylkesmannen) of Buskerud, and to eight units of the Norwegian Agricultural Extension Service (Norsk Landbruksrådgiving): Rogaland, Agder, Øst, Solør-Odal, Hedmark, Oppland, Sør-Trøndelag, and Nord-Trøndelag.

The questionnaires were sent during the period of November 2015 to February 2016. Answers were received during the same period, and from all recipients apart from the Norwegian Agricultural Extension Service of Oppland. The Norwegian Agricultural Extension Service of Sør-Trøndelag gave their answer on phone. The received reply forms are all shown here:

Answers from Norsk Landbruksrådgiving Rogaland:

Distrikt/fylke:	Rogaland

1. Er det/har det vært noen form for registrering eller kartlegging av forekomster i distriktet/fylket ditt?

Ja	Nei
	x

2. Hvis ja, beskriv kort hvordan arbeidet blir/har blitt gjennomført?

Svar:	

3. Er det registrert hønsehirse i ditt distrikt/fylke?

Ja	Nei
	x

4. Hvis ja:
   a. Kan du antyde noe om hvor lenge, antall år (eller siden når), det er registrert hønsehirse i distriktet?

Svar:	

   b. På ca. hvor mange driftsenheter er det registrert hønsehirse? (Kryss av ett alternativ):

1	2-3	4-10	Flere enn 10

c. Hva er omløpet på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Type omløp	Sett ett eller flere kryss:
Ensidig korn	
Korn/potet	
Korn/grønnsaker	
Korn/olje- eller proteinvekster	
Korn/gras	
Grass/grønnsaker.	
Annet (oppgi i så fall kultur under)	
Kultur:	

d. Hvor store er hønsehirsebestandene på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Størrelse på hønsehirsebestand	Sett ett eller flere kryss:
Én plante	
2-10 planter	
Flere enn 10 planter	
½ - 5 dekar er infisert	
Mer enn 5 dekar er infisert.	

e. På hvor mange av disse driftsenheter blir det sprøyta mot hønsehirse? (Kryss av ett alternativ):

0	1-3	4-10	Flere enn 10

f. På hvor mange av disse driftsenhetene er det frø- eller såkornproduksjon? (Kryss av ett alternativ):

0	1-2	3-10	Flere enn 10

5. Dersom du har kommentarer til spørsmålene eller øvrige opplysninger om utbredelse av hønsehirse i ditt distrikt/fylke, så kan du skrive dette inn i feltet under.

Eventuelle merknader:
Me kjenner ikkje til at det er registrert hønsehirse i vårt distrikt.

Answers from Norsk Landbruksrådgiving Agder:

Distrikt/fylke:	Agder

1. Er det/har det vært noen form for registrering eller kartlegging av forekomster i distriktet/fylket ditt?

Ja	Nei
	x

2. Hvis ja, beskriv kort hvordan arbeidet blir/har blitt gjennomført?

Svar:	

3. Er det registrert hønsehirse i ditt distrikt/fylke?

Ja	Nei
x	

4. Hvis ja:
   a. Kan du antyde noe om hvor lenge, antall år (eller siden når), det er registrert hønsehirse i distriktet?

Svar:	2015

   b. På ca. hvor mange driftsenheter er det registrert hønsehirse? (Kryss av ett alternativ):

1	2-3	4-10	Flere enn 10
	x		

   c. Hva er omløpet på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Type omløp	Sett ett eller flere kryss:
Ensidig korn	
Korn/potet	
Korn/grønnsaker	x
Korn/olje- eller proteinvekster	
Korn/gras	
Grass/grønnsaker.	
Annet (oppgi i så fall kultur under)	
Kultur:	

   d. Hvor store er hønsehirsebestandene på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Størrelse på hønsehirsebestand	Sett ett eller flere kryss:
Én plante	
2-10 planter	
Flere enn 10 planter	
½ - 5 dekar er infisert	x
Mer enn 5 dekar er infisert.	

   e. På hvor mange av disse driftsenheter blir det sprøyta mot hønsehirse? (Kryss av ett alternativ):

0	1-3	4-10	Flere enn 10
	x		

   f. På hvor mange av disse driftsenhetene er det frø- eller såkornproduksjon? (Kryss av ett alternativ):

0	1-2	3-10	Flere enn 10
0			

5. Dersom du har kommentarer til spørsmålene eller øvrige opplysninger om utbredelse av hønsehirse i ditt distrikt/fylke, så kan du skrive dette inn i feltet under.

Eventuelle merknader:

Answers from Fylkesmannen i Buskerud:

Distrikt/fylke:	Buskerud

1. Er det/har det vært noen form for registrering eller kartlegging av forekomster i distriktet/fylket ditt?

Ja	Nei
	x

2. Hvis ja, beskriv kort hvordan arbeidet blir/har blitt gjennomført?

Svar:	Vi er ikke kjent med at det er foretatt noen systematisk kartlegging av hønsehirse i Buskerud, men vi vet at NLR Viken, NLR Østafjells og trolig også Buskerud Bondelag og enkelte lokale bondelag har en viss oversikt.

3. Er det registrert hønsehirse i ditt distrikt/fylke?

Ja	Nei
x	

4. Hvis ja:
   a. Kan du antyde noe om hvor lenge, antall år (eller siden når), det er registrert hønsehirse i distriktet?

Svar:	Vi hørte vel om dette første gang i Buskerud for 2-3 år siden, i Øvre Eiker. Har et inntrykk av at det nå også finnes i flere kommuner i nedre Buskerud der det dyrkes korn.

   b. På ca. hvor mange driftsenheter er det registrert hønsehirse? (Kryss av ett alternativ):

1	2-3	4-10	Flere enn 10
			x

   c. Hva er omløpet på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Type omløp	Sett ett eller flere kryss:
Ensidig korn	x
Korn/potet	x
Korn/grønnsaker	?
Korn/olje- eller proteinvekster	x
Korn/gras	
Grass/grønnsaker.	
Annet (oppgi i så fall kultur under)	
Kultur:	

d. Hvor store er hønsehirsebestandene på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Størrelse på hønsehirsebestand	Sett ett eller flere kryss:
Én plante	
2-10 planter	
Flere enn 10 planter	
½ - 5 dekar er infisert	
Mer enn 5 dekar er infisert.	???

e. På hvor mange av disse driftsenheter blir det sprøyta mot hønsehirse? (Kryss av ett alternativ):

0	1-3	4-10	Flere enn 10
			?

f. På hvor mange av disse driftsenhetene er det frø- eller såkornproduksjon? (Kryss av ett alternativ):

0	1-2	3-10	Flere enn 10
			?

5. Dersom du har kommentarer til spørsmålene eller øvrige opplysninger om utbredelse av hønsehirse i ditt distrikt/fylke, så kan du skrive dette inn i feltet under.

Eventuelle merknader:
Vi har ingen oversikt over antall driftsenheter, eller utbredelse pr driftsenhet. Heller ikke om det sprøytes. Vi har derimot et klart inntrykk av at hønsehirsen sprer seg i kornkommunene, og at dette er et økende problem. Vi har hatt dette som tema på samling for kommunal landbruksforvaltning i fylket vinteren 2015 for å få opp kunnskapen om planten, utfordringene, og bekjempning.

Answers from Norsk Landbruksrådgiving Øst:

Distrikt/fylke:	Romerike + Oslo

1. Er det/har det vært noen form for registrering eller kartlegging av forekomster i distriktet/fylket ditt?

Ja	Nei
	x

2. Hvis ja, beskriv kort hvordan arbeidet blir/har blitt gjennomført?

Svar:	

3. Er det registrert hønsehirse i ditt distrikt/fylke?

Ja	Nei
x	

4. Hvis ja:

a. Kan du antyde noe om hvor lenge, antall år (eller siden når), det er registrert hønsehirse i distriktet?

Svar:	5-6 år

b. På ca. hvor mange driftsenheter er det registrert hønsehirse? (Kryss av ett alternativ):

1	2-3	4-10	Flere enn 10
		X	

c. Hva er omløpet på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Type omløp	Sett ett eller flere kryss:
Ensidig korn	X
Korn/potet	
Korn/grønnsaker	
Korn/olje- eller proteinvekster	
Korn/gras	
Grass/grønnsaker.	
Annet (oppgi i så fall kultur under)	
Kultur:	

d. Hvor store er hønsehirsebestandene på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Størrelse på hønsehirsebestand	Sett ett eller flere kryss:
Én plante	
2-10 planter	
Flere enn 10 planter	X
½ - 5 dekar er infisert	
Mer enn 5 dekar er infisert.	

e. På hvor mange av disse driftsenheter blir det sprøyta mot hønsehirse? (Kryss av ett alternativ):

0	1-3	4-10	Flere enn 10
	X		

f. På hvor mange av disse driftsenhetene er det frø- eller såkornproduksjon? (Kryss av ett alternativ):

0	1-2	3-10	Flere enn 10
X			

5. Dersom du har kommentarer til spørsmålene eller øvrige opplysninger om utbredelse av hønsehirse i ditt distrikt/fylke, så kan du skrive dette inn i feltet under.

Eventuelle merknader:
Viktig å informere om høsehirse. Enklere å hindre den i å etablere seg, enn å bli kvitt hønsehirse når de først er etablert. Bør registreres ved feltkontroll av såkornarealer for å unngå spredning med såvarer.

Answers from Solør-Odal Landbruksrådgiving:

Distrikt/fylke:	SOLØR-ODAL- EIDSKOG/HEDMARK

1. Er det/har det vært noen form for registrering eller kartlegging av forekomster i distriktet/fylket ditt?

Ja	Nei
	X

2. Hvis ja, beskriv kort hvordan arbeidet blir/har blitt gjennomført?

Svar:	

3. Er det registrert hønsehirse i ditt distrikt/fylke?

Ja	Nei
X	

4. Hvis ja:
   a. Kan du antyde noe om hvor lenge, antall år (eller siden når), det er registrert hønsehirse i distriktet?

Svar:	VI FIKK FØRSTE MELDING OM HØNSEHIRSE HOS ET MEDLEM I FJOR. DEN HADDE NOK DA VÆRT DER NOEN ÅR.

   b. På ca. hvor mange driftsenheter er det registrert hønsehirse? (Kryss av ett alternativ):

1	2-3	4-10	Flere enn 10
X			

   c. Hva er omløpet på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Type omløp	Sett ett eller flere kryss:
Ensidig korn	X
Korn/potet	
Korn/grønnsaker	
Korn/olje- eller proteinvekster	
Korn/gras	X
Grass/grønnsaker.	
Annet (oppgi i så fall kultur under)	
Kultur:	

   d. Hvor store er hønsehirsebestandene på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Størrelse på hønsehirsebestand	Sett ett eller flere kryss:
Én plante	
2-10 planter	
Flere enn 10 planter	
½ - 5 dekar er infisert	
Mer enn 5 dekar er infisert.	X

e. På hvor mange av disse driftsenheter blir det sprøyta mot hønsehirse? (Kryss av ett alternativ):

0	1-3	4-10	Flere enn 10
	X		

f. På hvor mange av disse driftsenhetene er det frø- eller såkornproduksjon? (Kryss av ett alternativ):

0	1-2	3-10	Flere enn 10
X			

5. Dersom du har kommentarer til spørsmålene eller øvrige opplysninger om utbredelse av hønsehirse i ditt distrikt/fylke, så kan du skrive dette inn i feltet under.

Eventuelle merknader:

Answers from Hedmark Landbruksrådgiving:

Distrikt/fylke:	Hedmarken

1. Er det/har det vært noen form for registrering eller kartlegging av forekomster i distriktet/fylket ditt?

Ja	Nei
	x

2. Hvis ja, beskriv kort hvordan arbeidet blir/har blitt gjennomført?

Svar:	

3. Er det registrert hønsehirse i ditt distrikt/fylke?

Ja	Nei
x	

4. Hvis ja:
   a. Kan du antyde noe om hvor lenge, antall år (eller siden når), det er registrert hønsehirse i distriktet?

Svar:	Forekomsten ble bekreftet 2015 etter mistanke fra bruker. Bruker fikk mistanke etter et faginnlegg av Hedmark Landbruksrådgiving (HLR) samme år. Forekomsten er betydelig og må ha utviklet seg over tid. Forekomsten må være minst 2-3 år gammel. Hirsa er kun registrert på ett skifte, men vi må regne med at den er spredd til flere skifter i samme driftsenhet.

   b. På ca. hvor mange driftsenheter er det registrert hønsehirse? (Kryss av ett alternativ):

1	2-3	4-10	Flere enn 10
x			

c. Hva er omløpet på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Type omløp	Sett ett eller flere kryss:
Ensidig korn	x
Korn/potet	
Korn/grønnsaker	
Korn/olje- eller proteinvekster	
Korn/gras	
Grass/grønnsaker.	
Annet (oppgi i så fall kultur under)	
Kultur:	

d. Hvor store er hønsehirsebestandene på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Størrelse på hønsehirsebestand	Sett ett eller flere kryss:
Én plante	
2-10 planter	
Flere enn 10 planter	X (uhåndterlig mange)
½ - 5 dekar er infisert	
Mer enn 5 dekar er infisert.	x

e. På hvor mange av disse driftsenheter blir det sprøyta mot hønsehirse? (Kryss av ett alternativ):

0	1-3	4-10	Flere enn 10
	x		

f. På hvor mange av disse driftsenhetene er det frø- eller såkornproduksjon? (Kryss av ett alternativ):

0	1-2	3-10	Flere enn 10
	x		

5. Dersom du har kommentarer til spørsmålene eller øvrige opplysninger om utbredelse av hønsehirse i ditt distrikt/fylke, så kan du skrive dette inn i feltet under.

Eventuelle merknader:
Bruker er såkornprodusent og mener selv at smitten har kommet med infisert, utenlandsk såvare. Dette er ikke bekreftet. Brukeren har sett plantene, men oversett dem som hundegras i flere år. Det er tydelig to ulike populasjoner i åkeren, en med opprett stengel og en mer flattrykt, «krypende» populasjon. Populasjonene finnes på samme areal, men på ulike steder. Et begrenset areal med svært høy tetthet ble sprøytet med glyfosat for å hindre frøproduksjon, synlige aks og planter ble luket. Det har ikke vært sprøytet mot hønsehirse tidligere, men det vil det fra sesongen 2016. Det har vært informert om hønsegras på fagmøter i regi av HLR og på fagmøte for felleskjøpets såkornprodusenter.

Answers from Norsk Landbruksrådgiving Nord-Trøndelag:

Distrikt/fylke:	Nord-Trøndelag

1. Er det/har det vært noen form for registrering eller kartlegging av forekomster i distriktet/fylket ditt?

Ja	Nei
x	

2. Hvis ja, beskriv kort hvordan arbeidet blir/har blitt gjennomført?

Svar:	På bakgrunn av auka problem i Vestfold og at det er rapportert funn ved importmottak(?) i Nord-Trøndelag, har det blitt ekstra oppmerksamheit på Hønsehirse ved kontroll av kontraktareal for såkornproduksjon til Felleskjøpet. Det er ikkje gjort funn ved denne kontrollen. Vi har heller aldri funne høsehirse eller fått inn misstenkelige planter ved markdagar eller i andre samanhengar i min periode som rådgjevar frå 1982 til d.d.

3. Er det registrert hønsehirse i ditt distrikt/fylke?

Ja	Nei
	x

4. Hvis ja:
   a. Kan du antyde noe om hvor lenge, antall år (eller siden når), det er registrert hønsehirse i distriktet?

Svar:	I følge artsdatabanken er det registrert funn av hønsehirse i Nord-Trøndelag i tilknytting til kornmottak, men vi har aldri mottatt melding om når og at det har blitt spredning til nærliggende kornåker.

   b. På ca. hvor mange driftsenheter er det registrert hønsehirse? (Kryss av ett alternativ):

1	2-3	4-10	Flere enn 10

   c. Hva er omløpet på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Type omløp	Sett ett eller flere kryss:
Ensidig korn	
Korn/potet	
Korn/grønnsaker	
Korn/olje- eller proteinvekster	
Korn/gras	
Grass/grønnsaker.	
Annet (oppgi i så fall kultur under)	
Kultur:	

   d. Hvor store er hønsehirsebestandene på disse driftsenhetene? (Kryss av flere alternativer dersom nødvendig):

Størrelse på hønsehirsebestand	Sett ett eller flere kryss:
Én plante	
2-10 planter	
Flere enn 10 planter	

Størrelse på hønsehirsebestand	Sett ett eller flere kryss:
½ - 5 dekar er infisert	
Mer enn 5 dekar er infisert.	

e. På hvor mange av disse driftsenheter blir det sprøyta mot hønsehirse? (Kryss av ett alternativ):

0	1-3	4-10	Flere enn 10

f. På hvor mange av disse driftsenhetene er det frø- eller såkornproduksjon? (Kryss av ett alternativ):

0	1-2	3-10	Flere enn 10

5. Dersom du har kommentarer til spørsmålene eller øvrige opplysninger om utbredelse av hønsehirse i ditt distrikt/fylke, så kan du skrive dette inn i feltet under.

Eventuelle merknader:

Appendix 4

Questions regarding spread and severity of *Echinochloa crus-galli* infestations in your country.

The same questionnaire was sent to one colleague in each of the countries Sweden, Finland and Denmark in December 2015. Here are the reply forms from Sweden and Finland. Denmark did not answer to this questionnaire.

Answers from Finland:

Your name:	Jukka Salonen
Country:	Finland

1. Is *Echinochloa crus-galli* regarded as a challenge when it comes to weed control in your country? (Tick off one of the alternatives)

No	Yes	Yes, very much so
X		

2. Is the area infested with *Echinochloa crus-galli* increasing, stable or decreasing? (Tick off one of the alternatives)

Increasing	
Stable	X
Decreasing	

3. If the area infested with *Echinochloa crus-galli* is increasing, please indicate which pathways you think are the main contributor to this increase:

Answer:
Only very few spot areas (gardens, small fields) infested for the moment. Seed feed (e.g. sunflower seeds) for garden birds is the main pathway.

4. In which crops does *Echinochloa crus-galli* appear and to what extent? (Tick off one alternative for each crop)

Crop	No reports	Rare	Common	Very common
Spring cereals	X			
Winter cereals	X			
Maize	X			
Vegetable crops	X			
Seeds for planting	X			

Crop	No reports	Rare	Common	Very common
Other		X Potato		

5. What are the most common control measures in your country when it comes to *Echinochloa crus-galli*?

Answer:
Summer in Finland is (normally) not warm enough for Echinochloa seed production. No particular control required. Mechanical control in potato fields.

6. If you have any comments to this questionnaire or other information concerning *Echinochloa crus-galli* in your country, please fill inn here:

Comments:
The Turku archipelago and the island of Åland are sometimes warm enough to favour the species occurrence. Likewise, the south-eastern corner of Finland is potential region because Echinochloa is present in Russia. Scenarios for the future in the attached article. Now that maize is not (yet) commonly grown in Finland and we do not get foreign weed seed with it the threat is very limited for the coming 10 years. Climate change is needed (but not hoped).

Answers from Sweden:

Your name:	Lars Andersson
Country:	Sweden

7. Is *Echinochloa crus-galli* regarded as a challenge when it comes to weed control in your country? (Tick off one of the alternatives)

No	Yes	Yes, very much so
	x	

8. Is the area infested with *Echinochloa crus-galli* increasing, stable or decreasing? (Tick off one of the alternatives)

Increasing	x
Stable	
Decreasing	

9. If the area infested with *Echinochloa crus-galli* is increasing, please indicate which pathways you think are the main contributor to this increase:

Answer:

Answer:
Present in ruderal areas since long. Seeds have probably been more or less continuously imported via bird seeds. Short-day plant, and therefore first a problem in long-season crops like maize and sugar beets. The last couple of years it has been reported as a problem in crops like spring barley. Genotypes with earlier germination or earlier seed setting? Also, it has been restricted to southernmost Sweden but is now reported from areas at latitude 60°N.

10. In which crops does *Echinochloa crus-galli* appear and to what extent? (Tick off one alternative for each crop)

Crop	**No reports**	**Rare**	**Common**	**Very common**
Spring cereals		x		
Winter cereals	x			
Maize			x? (south)	
Vegetable crops		x		
Seeds for planting	?			
Other				

11. What are the most common control measures in your country when it comes to *Echinochloa crus-galli*?

Answer:
Herbicides

12. If you have any comments to this questionnaire or other information concerning *Echinochloa crus-galli* in your country, please fill inn here:

Comments:
Emergence and phenology of E. crus-galli is not being studied in an EWRS project within the working group Germination and Early Growth (chairperson Kirsten Tørresen). Our group participate in the experiment.