A10. Keywords

Max. 5 keywords to describe the project activity.

Arable crops, higher productivity, low environmental impact, knowledge chain barriers, mobile farm N resources

A11. Short project description/summary on objectives, activities, and expected results, both in Danish and English language (max 1500 characters, incl. spaces for both languages)

Danish:

Den forventede udvidelse af det økologisk dyrkede areal i Danmark er betinget af øget planteproduktion, som kræver højere og mere stabile udbytter. Denne udfordring skal kunne løses samtidig med at importen af konventionel husdyrgødning udfases og miljøpåvirkningen, f.eks. udledningen af drivhusgasser, reduceres væsentligt. HighCrop har to hoved-hypoteser: 1) Højere udbytter og mindre miljøpåvirkning kan opnås ved at inddrage flerårige energiafgrøder og forbedre styring af kvælstof (N) frigivet fra efterafgrøder, grøngødninger og afgrøderester; og 2) Lave udbytter i praktisk økologisk jordbrug skyldes et vidensgab mellem forskning og praksis, som kræver nye strategiske planlægningsværktøjer for at løse. HighCrop bygger på et tæt samarbejde mellem forskning, udvikling og formidling. Forskningen vil øge kendskabet til effekter af N-dynamik og ukrudtstryk på afgrødeproduktivitet, N-udvaskning, drivhusgasemissioner og biodiversitet. Udvikling og formidling vil bygge på nye koncepter for beslutningsstøtte og vidensformidling baseret på en detaljeret analyse af barrierer på bedriften samt i produkt- og videnskæderne. De nye koncepter og værktøjer vil blive testet på økologiske bedrifter og formidlet til danske økologiske rådgivere og landmænd. HighCrop vil også analysere og syntetisere viden gennem afholdelse af en serie workshops med fokus på forskellige værdikæder.

English:

The projected expansion of organic farming in Denmark is conditioned on increased arable crop production, which requires higher and more stable crop yields. This must be achieved while also phasing out the use of imported conventional manure and reducing environmental impacts, such as greenhouse gas (GHG) emissions. HighCrop has two main hypotheses: 1) Higher yields and reduced environmental impact can be achieved by introduction of energy crops and improved management of nitrogen (N) in catch crops, green manure and crop residues; and 2) Low yields in practical arable organic farming are caused by a knowledge gap that requires new strategic management tools to overcome. HighCrop applies a comprehensive approach linking research, development and demonstration. Research will improve our understanding of effects of N dynamics and weed pressure on crop productivity, N leaching, GHG emissions and soil biodiversity to derive essential models for N and weed management in organic arable cropping systems. The key to development and dissemination will be new knowledge transfer tools which will be targeted by identification of real and perceived barriers on the farm, as well as in supply and knowledge chains. These concepts and tools will be tested on organic farms and disseminated to Danish organic advisers and farmers. HighCrop will also make use of participatory approaches to synthesize and disseminate knowledge by organising workshops focusing on different supply chains.

A12. Project description

(All parts of A12 must be filled out. Use "Garamond" as font, and font size 12, single spaced)

A12.1 The project objectives (2-3 lines). HighCrop will provide the scientific background for a substantial increase in productivity of organic arable crop production while ensuring high environmental credibility. HighCrop will develop the tools needed for implementing novel cropping systems in practical organic farming.

A12.2 The background and idea (hypotheses) incl. the national and international "state of art" and incl. references relevant for the section (max. ¾ page). Arable cropping provides grains and seeds needed for both food and livestock feed, in particular for pig and poultry production. The projected expansion of organic farming in Denmark is conditioned on an increase in arable crop production, which requires higher and more stable crop yields to make production profitable and to provide the required quantities and qualities for food and feed consumption (R1). There has over the past two decades been little, if any, increase in achieved yields of arable crops in Danish organic farming. Studies undertaken in FØJO-III point to limiting nutrient (in particular nitrogen (N)) availability and weed pressure (in particular from perennial weeds) as being the primary reasons for low yields (R2, R3). In addition, sustainability issues related to nitrate leaching as affected by tillage and catch crop management (R4), nitrous oxide emissions from management of manures and catch crops (R5, R6), and biodiversity effects of different arable crop rotations and crop management still need to be resolved in a way that can be integrated in practice (R7, R8). The two main hypotheses of HighCrop are: 1) Higher yields and less environmental impact are achievable by including perennial energy crops and improving cycling of N in catch crops, green manure and crop residues; and 2) Low yields in arable organic farming are caused by a knowledge gap, which requires new strategic management tools to overcome. Organic arable crop rotations may have substantial inputs of N through biological N in pulses, green manures and catch crops, but the N returned to the soil in crop residues by mulching and soil incorporation is often not effectively used on the farms – also resulting in increased risk of N leaching and N2O emissions (R9, R10). Improved management can be achieved by harvesting straw, catch crops and green manures for silage, compost or biogas digestion before the end product is used as manure (R11). However, the N use efficiency (NUE), yield response, and associated N losses and emissions of different uses of these various nutrient sources are mostly not known. Controlling perennial weeds requires a combination of highly competitive crops (e.g. bioenergy crops), catch crops and physical control methods (R12). Novel cropping system and management measures that may be used for increasing yields and yield stability include the use of species and variety mixtures, seed vitality, tillage, manure application technologies etc. Managing arable organic crop rotations is a complex task and demands a high knowledge intensity, and current decision support systems are most likely not sufficient to drive the development of novel practices that can ensure higher productivity at low environmental impact. There are probably a number of barriers limiting the adoption of sustainable practices (R13). These obstacles can be of economic, technical, practical, biological and sociological character, e.g. in terms of lack of technical solutions, conflicts with other activities of the production systems, lack of marketing possibilities, lack of knowledge and skills, conflicting ideas and values. There is a need for mapping and analyzing real barriers and how these can be overcome.

A12.3 The projects contribution to solving important challenges for the organic food, agriculture and aquaculture sectors and the general political goals regarding food, agribusiness and environment as expressed in the governments Green Growth programme. Including an explanation of the projects focus on respectively the entire product/value chain or selected parts here of (e.g. primary production, processing, trade and transport) – max. ½ page. HighCrop will help solve the crucial challenges for arable crop production in Danish organic farming, the aim being to clear the way for a market-based doubling of the area with organic agriculture by 2020. HighCrop will focus on growth and robustness aiming to increase overall productivity of organic food, feed and energy under core concerns for the organic principles and integrity. Measures and tools for increased growth will be developed and documented with regard to environmental protection, energy self sufficiency, (bio)diversity, and the intention to discontinue the import of nutrients in conventional manure. Robustness is a precondition for increased yields in organic arable farming, and HighCrop will identify and implement a series of short- and long-term management measures that contribute to increasing robustness. Organic crop production should always be evaluated at the crop rotation level, because long-term sustainability is not always in harmony with the short-term economic viability. HighCrop will develop simple strategic management tools, which, in addition to currently used management tools, take long-term effects and integrity questions into consideration and still enable the farmer to act on market-based opportunities. In particular the optimization of NUE at crop rotation level and the prevention of weed propagation will be addressed. Another major focus of HighCrop is reducing in net GHG emissions from arable cropping systems to contribute to achieving the goals in the Climate Strategy of Organic Denmark. HighCrop will adopt an integrated approach that links bioenergy and fertiliser supply chains with food and feed production and supply: i) in the design of field experiments; ii) through interactive discussions with stakeholders; and iii) in the development of knowledge transfer chains from theory to practice, from research to farmer.

A12.4 The projects innovative value, relevance and effect including the specific barriers and development potential for the organic sector the project will solve and/or support (max. ½ page).

HighCrop will provide the scientific background for a substantial increase in the productivity of organic arable crop production with a credible environmental profile, and the project will develop and test the tools necessary for implementing novel cropping systems in arable organic farming. These novel approaches are based on improved recycling of on-farm resources (green manure, catch crops, crop residues), on better performance of fertility enhancing management factors (catch crops with and without biological N fixation and green manure crops) that may also be used for bioenergy and as highly competitive crops to prevent perennal weeds, and on less intensive tillage for crop establishment and weed control that will reduce N losses and GHG emissions and improve fertility (R14, R15, R16). HighCrop will develop and test simple strategic management tools for farmers and advisors that include both short-term and long-term aspects with respect to productivity, economy and integrity. These tools will build on previous organic farming research and the novel systems tested in HighCrop. This is designed to close the knowledge gap between research and practices and will improve decision making at farm level and thus add to the growth, integrity and robustness of organic arable cropping systems. HighCrop will identify barriers of technical, practical, biological, economical and sociological characters for an increased growth in arable organic farming. HighCrop applies a participatory approach throughout the project to overcome major barriers in the flow of knowledge and technologies between research and practice.

A12.5 Description of activities, methods and expected results divided into work packages with clear denotion of which activity the applicant consider to be either Research, Development or Demonstration. The coherence between work packages must be clearly described and the relation between activities and the tables with milestones and deliverables must be logical and consistent. Moreover, the primary target groups should be clearly identified with a description of how these will be met by the project (max. 1 page per WP and max. 3 pages in total). The project will investigate novel strategies to ensure crop N supply at low environmental impact (WP4). This will be accompanied by a sustainability assessment at crop rotation level (WP3) and models designed to optimize N use and perennial weed management for advisory purposes (WP2). New management practices will be tested on organic farms (WP5), and barriers for accept and implementation of new management systems will be explored (WP6). This forms the basis for developing decision support tools (WP7) that can be disseminated to practical farming and related bioenergy, food and feed supply chains (WP8).

WP1. Project management (research, Jørgen E. Olesen, JPM)
Efficient management of the project by means of biannual meetings, and establishment of an efficient management structure will be ensured – see further details below. The coordinator will also ensure close cooperation with related national and European projects. Supply chain workshops will be organised in collaboration with WP8 involving main project stakeholders.

WP2. Principles for N cycling and weed control (research, Jørgen E. Olesen, JPM, PBS)
WP2 will develop simple models and concepts for improved N and weed management in arable organic farming. They will be tested in WP5 and developed into decision support tools in WP7. Data from developing these tools are available data (in databases) from previous Danish research projects, field experimental databases, literature and new data from WP3+4.
Task 2.1 Development of a N management tool. A simple model-based tool for estimating N availability for arable crops will be developed based on estimates of soil N-mineralisation and NUE from incorporated catch crops and various types of manure. The model will further use an adapted emission factor approach to estimate nitrate leaching and N2O emissions as dependent on cropping system design and N management. Finally a simple soil carbon balance model will be set up based on the C-Tool model (R17) for estimating soil carbon balance of various arable systems depending on N management. The development will also draw in information on existing N models, such as NDICEA (R18) and EU-Rotate_N (R19).
Task 2.2 Development of a weed management tool. Existing data from the CRO experiment (see WP3) will be extracted, analysed and synthesized to describe and quantify perennial weed dynamics under the influence of different crop rotations and nutrient management factors. The synthesis will be discussed in relation to the literature and include information produced in the ongoing WEEDS project on new control tactics and strategies against Cirsium arvense, Tussilago farfara and Elytrigia repens. This will be used to formulate concepts of weed control tactics and strategies for perennial weed management.

WP3. Cropping systems experiments (research, Peter Sørensen, JPM, PBS)
WP3 will evaluate the productivity, biodiversity and environmental impacts of organic crop rotations with novel crop management concepts that seek to improve yields and reduce weed infestation. A long-term cropping system experiment at Foulum initiated in 1997 will serve as experimental platform for investigations of crop rotation related questions to ensure that long-term fertility and system effects are represented (R20).
Task 3.1. Management of the cropping system experiment at Foulum
The CRO experiment comprises eight different arable cropping systems in a factorial design (R21). The factors are crop rotation (organic green manure (O2), organic cash crop (O4) and conventional cash crop (C4)), manure (with (+M) and without (-M)) and catch crop (with (+CC) and without (-CC)). Not all combinations are included in the experiment. The crops include spring cereals (all), grain legumes (O4 and C4), oilseed hemp (O4 and C4), potato (all) and a 2-year lucerne green manure (O2). In O2/+M manure application will be based on recirculation, where nutrients in cuts from the green manure via anaerobic digestion are redistributed to the non-N2 fixing crops in the rotation. In the O2/-M treatment all plant material in the green manure crop is mulched. Soil samples are taken in the plough layer at the end of the experiment.
Task 3.2. Yield and biomass measurements. All cash crops will be harvested at maturity and DM and N of grains/seed, tubes and straw, and oil content in hemp seed will be determined. Samples will be taken to determine the above-ground crop residues (legume and non-legume) returned to the soil. Weed biomass campaigns will be carried out at anthesis of the cereals in all cereal, pulse and row crops. Attacks of pests and diseases will be recorded.
Task 3.3. N2O emissions and N leaching. Short-term field campaigns for N2O emissions will be carried out in 2011 and 2012 using static enclosures (R5). Four treatments based on the O4 rotation will be included: +CC/-M, +CC/+M, -CC/+M, and the -CC/-M combination by partial omission of manure in –CC/+M field plots. Soil samples will be taken for monitoring of mineral N dynamics. N leaching will be estimated using ceramic suction cups that are permanently installed in selected plots the CRO experiment.

Task 3.4 Microbial biomass and biodiversity. Soil samples will be collected in late spring and soil microbial diversity in each treatment characterized using two contrasting methodologies. DNA will be extracted and amplified by PCR and sequencing, targeting a key enzyme in soil N turnover, i.e. nitrite reductase (R23). Other subsamples will be used for analysis of polar lipids (PLFA), which quantifies the microbial biomass and provides a fingerprint of the microbial community (R24).

WP4. Nutrient management (research, Søren O. Petersen, JPM, DTU)
WP4 will provide basic information for optimising NUE of green manures in organic rotations for improved yields and a reduction of N losses. This will be done in consideration of the upcoming stop for import of conventional manure. Biogas treatment holds promise as strategy to improve NUE, but few biogas plants still exist. WP4 therefore focuses on alternative management solutions, which can be readily implemented on organic farms. The knowledge gained from the work described below can help optimize decisions on tillage and timing of (green) manure application.
Task 4.1. Green manure as mobile fertilizer. Red clover-grass and lucerne will be used for preparation of compost (aerobic), silage (anaerobic) and digestate (anaerobic) in a factorial setup using a pilot-scale manure storage facility, where N and C retention and GHG emissions (N2O, CH4, NH3) can be quantified (collaboration with CLEANWASTE).
Task 4.2. NUE of green manure. The NUE of treated green manures will be investigated in a factorial field experiment with application of silage, compost and anaerobically digested manure. Short-term N2O emissions and harvest yields will be determined. In separate treatments the interaction between green manure and tillage strategy (moldboard ploughing versus shallow tillage) will be examined with respect to N2O production and emission during 4-6 weeks after incorporation.
Task 4.3. C and N retention. The contribution of the green manures to N and C retention in soil will be evaluated in a laboratory incubation study with 15N labeled green manures, where the importance of crop residue distribution, soil N status and moisture will be investigated.

WP5. Farm scale experiments (demonstration, Inger Bertelsen, VFL)
WP5 will demonstrate promising management options for higher and more stable crops yields developed in WP2-4 and previous projects in practice in replicated field trials on organic farms. The measures tested are taken as those that may achive higher and more robust production and contribute to improved long-term economic viability and less environmental impact.
Task 5.1. Improved crop competition. The most important management options for improved N and weed management identified in WP2 (e.g. mobile green manure, bioenergy crops) will be demonstrated.
Task 5.2 Crop mixtures to increase crop yield stability on variable soils. Classic field trials are preferably carried out in homogenic fields thus not reflecting effects of varying soil conditions. We hypothesize that in heterogenic fields crop mixtures will be more stable and robust than a pure stand of individual mixture components. This will be demonstrated both within heterogenic field and in different fields.
Task 5.3 Catch crops for biogas. The use of catch crops for biogas production is only sustainable when the yield exceeds the harvest costs both economically and energy-wise. The demonstrations to maximize catch crops yields include: 1) Sowing time in autumn for different catch crop types for high biomass production. 2) Screening of new catch crops for biomass production.

WP6. Farm and food chain barriers (research, Egon Noe, JPM, ØL)
WP 6 will explore knowledge and product chain barriers for implementing principles and techniques for robust, productive and environmentally benign organic arable systems as well as the potentials and obstacles for applying these in practical organic farming systems using a case study approach involving 8-10 organic arable farming systems. This involves 3 steps: 1) Introducing principles and techniques to the farmers and discuss with the farm manager (management team) the perceived barriers for adopting the suggestions. The interview will focus on knowledge chain barriers and relational barriers like marketing possibilities, technical support (e.g. access to special equipment), 2) Follow-up visit (interview) on the experienced obstacles in

implementing principles and techniques, followed by a discussion of further possibilities. 3) Stakeholder workshop (SW) involving key surrounding actors identified in steps 1 and 2. The main focus of the SW is to identify and discus a) what is not real barriers, b) real barriers that can readily be overcome by agreements or rearrangements, and c) real barriers that needs long-term convolutions and rearrangements and d) barriers likely not to be overcome.

WP7. Cropping system planning tools (development, Erik Fog, VFL)
WP7 will develop cropping system planning tools for use by farmers and advisers to achieve better tactical and strategic management of organic arable cropping systems resulting in high and stable crop production, low environmental impact and stable income. The specific targets of these tools will be defined based on the farm barrier surveys in WP6. The models for rotations, carbon and N management and weed control are designed from the realizations in WP2-5 and they will integrate short- and long-term economic, ecological and environmental concerns.
Task 7.1 Web-based planning tool. Existing IT tools for planning of crop production and rotations on farms will be extended with features that fit with organic plant production and make it easier to optimise short- and long-term management of N resources and weed control. The N- and C-tools from WP2 will be integrated. A spreadsheet planning tool developed at VFL-Plant-Production will form the basis for the tool. The new tool will be made accessible from the internet.
Task 7.2: Farm manager decision tool. Development and test of a simple but efficient tool to motivate farmers to use and implement the optimal set up for robust organic plant production. In cooperation with plant production advisers a tool based on German experiences with visualisation of the farmers goals and values will be developed. Important barriers identified in WP6 will be given special focus and a prototype of the tool will be evaluated by farmers interviewed in WP6.

WP8. Demonstration and dissemination (demonstration, Inger Bertelsen, VFL, ØL)
WP8 will demonstrate the importance of the sustainability issues exposed in the other WPs and put it in relation to the short-term benefits and to supply chains.
Task 8.1: Demonstrations. The demonstrations will consist of physical and web-based activities:
1) Field days at experimental fields at Foulum. Field days are courses based on participatory education developed by VFL. The main target group is organic advisers (of which several are very experienced). The field days give advisers thorough education, which enables them to better use new research in their advisory activties. 2) Open days in the field trials (WP4, WP5) and the cropping system experiments (WP3) for all interested. Organic farmers being the primary target group. The results from WP2 will be presented and the farmers in WP6 will be specially invited. New technical solutions will be presented. 3) Knowledge information sheets presenting key results from HighCrop will be made available on the project website as well as other website, e.g. those of ICROFS, VFL and ØL.
Task 8.2: Implementation of planning and decision tools. The uptake in organic farming of planning tools developed in WP7 will be promoted through two in-service training courses aimed at plant production advisers and dedicated farmers. The training of the planning and decision tools will further be conducted under supervision on selected organic farms.
Task 8.3: Supply chain workshops. Three supply chain workshops will be organised together with WP1 focusing on three different topics: 1) bioenergy, biogas and green manure chains, 2) feed production and feed quality chain, and 3) food production and food quality chain. The workshops will cover pre- and post-chain actors and focus on the integration of knowledge from HighCrop into the supply chains. Experts will be invited from both Denmark and neighbouring countries, and the results of the workshops will be summarised in articles to be disseminated through the web and through journals focusing on the respective supply chains.

A12.6 Description of how it will be ensured that the project results can be implemented in practice and perhaps commercialized (max. ½ page). HighCrop adopts several approaches for bridging the gap between research and practice, and this bridging is embedded into the project workflow as well as the management structure. The main hypotheses of HighCrop is that crop yields can be increased and environmental impacts reduced through improved on-farm management of nutrients (green manure, catch crops, residues etc) in combination with improved weed control and other measures to increase robustness of crops. It is also hypothesised that much of the knowledge needed already exists, but that various barriers and knowledge gaps prevent this knowledge from being implemented in practice. This may even be one of the reasons for the current low interest for conventional farmers to convert to organic arable production systems. HighCrop will address these issues with a particular focus on improving practical knowledge on highly efficient and robust cropping systems and by developing decision support and planning tools that will support both tactical and strategic decisions in crop management. The transfer of knowledge in practice is specifically covered by WP8 and will include a wide range of activities, such as field days aimed at advisers, open field days and machine and cropping system demonstration aimed at farmers, in-service training of advisers and farmers for planning and decision tools, and workshops dedicated to other actors in the supply chain. These disseminiation activities build on the long-standing and excellent experience of the participating institutions (VFL and ØL) in terms of what actually works and on strong links and contacts with key stakeholders in the supply chain. VFL also has existing IT based advisory tools on which HighCrop will build the decision support systems. Special emphasis will be given to ensure communication to end-users via the project web-site, where dedicated information will be made available and supplemented with a discussion forum.

A12.7 Description of possibilities for a general utilisation of the results (max. ½ page). HighCrop challenges the concept that productivity of organic arable crop production is inherently low, and that measures to increase productivity will be accompanied by increased environmental impacts. We attempt to document and demonstrate 1) that higher yields can be achieved by better recycling and targeting of on-farm N resources, 2) that additional benefits can be obtained by integrating bioenergy (biogas, biomass crops) into the crop rotations by providing higher NUE and by improved weed control, and 3) that such management measures will require novel thinking within advice and practical farming involving more strategic thinking in production planning. At the society level this knowledge and the resulting change in farming practices will have some co-benefits that need to be incorporated into policies and within environmental regulations. The research results will thus be highly relevant for developing future policies on sustainability of organic farming practices, in particular related to development of measures to promote low-emission farming systems. The improved knowledge on N2O emissions as influence by catch crop and green manure management should lead to recommendations on practices in organic farming that will minimize N2O emissions. This information will not only support sustainable farming policies. It will also provide information relevant for national GHG emissions reporting, and for future revisions of the IPCC guidelines for emissions accounting from agriculture.

A12.8 Description of the coherence between the research, development and demonstration activities in the project, including involvement of relevant users of the results (max. ½ page).
HighCrop applies a comprehensive and holistic approach linking research, development and demonstration. In WP3+4 dedicated research activities, from laboratory and field-plot scale to the crop rotation level, will improve the understanding of N cycling and weed effects on crop productivity, N leaching, GHG emissions and soil biodiversity. The research in WP2 will synthesize results from previous projects and from the HighCrop research activities to derive essential models and concepts for N and weed management in organic arable cropping systems. The scientific results will be presented at both scientific conferences and disseminated through meetings for advisors and farmers. However, the key in HighCrop to development and dissemination will be new, improved knowledge transfer tools supplied by WP7 to close the knowledge gap between research, advice and practice. To better target the development and implementation of these tools, HighCrop will in WP6 identify barriers for improved management of organic arable farming systems both on-farm and in the supply and knowledge chains. Some of the identified opportunities will be demonstrated through on-farm experimentation in WP5, and these results along with the knowledge transfer tools developed in WP7 will be disseminated in WP8. In addition HighCrop will make use of participatory approaches to synthesize and disseminate knowledge, in particular through organisation of several supply

chain workshops that not only target the physical supply chains, but also the knowledge chains and barriers and gaps in these chains.

A12.9 Project organisation, management and administration (max. ½ page). HighCrop will be coordinated by professor Jørgen E. Olesen, AU, who has extensive experience in project management from leading national and European research projects and project components, and he has a broad scientific network and contributes to policy advice at national and international levels. He will be responsible of enforcing a detailed workplan and time schedule to secure fulfilment of milestones and deliverables. He will also be responsible for the contact to the GUDP office. For the administrative part of the project management he will be assisted by auditor Britta Breinbjerg to secure timely reporting, financial accounting etc. Jørgen E. Olesen and the WP leaders will form the project core group that will oversee the timely development of HighCrop. The project core group will meet 3-4 times per year either physcially or through telephone meetings. Two of these meetings will be organised jointly with the bi-annual project meeting (winter and early summer) encompassing all project participants for presentation and discussion of results and plans. Major project decisions on redirecting the work, on workshops, dissemination of results etc. will be taken in here. Annually one of these project meetings will be held back-to-back with a one-day supply chain workshop (see WP8). Key stakeholders that are involved in the supply chain workshops will also be invited for one annual meeting, where results are presented and discussed. Key stakeholders include representatives from the supply chain: bioenergy industry (networked through CBMI), machine industry (e.g., Samson for manure application), and seed and feed companies (e.g., DLG), and food processing and retail companies. Other stakeholders related to societal interests (NGOs and relevant governmental bodies) will also be invited for these meetings, where relevant. A website will be set up for the project to facilitate internal communication and external dissemination of project results.

A12.10. The technical competences of the partners and their contribution to the project including how they complement each other (max. 5 lines per partner).

Aarhus University, Dept. of Agroecology and Environment (JPM) conducts research and policy advice on effects of agriculture on production and environmental impact. A large emphasis of the research is on cycling of carbon and N in cropping systems and the resulting effects on crop productivity and environmental impacts through soil quality, carbon sequestration, nitrate leaching and nitrous oxide emissions. This includes use of modelling and long-term experiments.

Aarhus University, Dept. of Integrated Pest Management (PBS) contributes to efficient and environmentally acceptable prevention and control of weeds, plant diseases and pests in plant and livestock production, in the food industry and in society in general. The research covers several aspects of non-chemical weed control, including preventive measures by improving crop competitiveness and use of mechanical control methods.

Danish Technical University, The Biosystems Division, Risø (DTU) has long and well reputed experience in application and development of stable isotope techniques for studying soil-plant and soil-atmosphere interactions. Risø houses state-of-the-art instrumentation for stable isotope and GC-analysis. This included research on soil-atmosphere exchange processes with focus on GHG emissions.

Knowledge Centre for Agriculture (VFL) has a broad experience and expertise in advising farmers and developing advisory tools for agricultural advisers. It is knowledge centre for all agricultural advisers in Denmark. It cooperates with research institutions in Denmark and other countries in projects designed to produce new knowledge and possibilities for Danish farmers. It conducts organic field trials in cooperation with AgroTech and the local field trial units.

Organic Denmark (Økologisk Landsforening) (ØL) is an association of farmers, companies and consumers that are assembled to create new ways for more organic food and sustainable change, and the activities cover the whole chain from farm to fork. ØL has high competences in conducting development projects for organic farming and supplying advisory service and training for organic and interested conventional farmers.

A12.11. Expected collaboration with other research institutions/companies nationally and internationally (max. ½ page). HighCrop has strong links to other national and European research and advisory activities within organic farming and related agroecological and agroenvironmetal areas. JPM is currently collaborating with leading European research institutions in three EU projects: 1) NitroEurope, where JPM and DTU collaborates with other European universities and research institutions to quantify N cycling, losses and emissions from agricultural ecosystems, 2) LegumeFutures, where JPM collaborates with a range of other research institutions (coordinated by SAC in UK) on addressing the potentials of legumes for N cycling and for grain production and where data from the CRO experiment plays an essential role, 3) AgTechOrg funded under CoreOrganic, and which addresses effects of N cycling in organic systems on quality of wheat. PBS chairs the European working group on Physical and Cultural Weed Control comprising extensive knowledge on perennial weeds. PBS is involved in the the European Network for the Durable Exploitation of Crop Protection Strategies (ENDURE) covering the majority of crop protection expertise within the EU. VFL has good contact to the organic advisory service in Germany: Bioland Beratung who has developed an advisory and planning tool based on pictures. This tool makes it easy to visualize and realize what is most important to an actual farmer and make grounds for the management decisions taken. HighCrop will further developed this tool to fit with decisions taken in relation to crop planning on organic farms in Denmark. HighCrop will link up with the Danish DSF-funded CLEANWASTE project, which focuses on novel methods for handling of waste (including manure). The PhD working within CLEANWASTE at JPM on GHG emissions from novel animal manure management systems will include GHG emissions from processing and storage of green manure (silage and compost) from HighCrop into the experimental and modelling work. JPM will collaborate with Dr. Anders Primé at Biological Institute, University of Copenhagen on characterisation of soil biological diversity using DNA markers.

A12.12. The relation to previous projects within the projects focus areas (if any) including references to these (max. ½ page). HighCrop builds on experiences and data from a number of previous and ongoing projects within Danish organic farming research funded under DARCOF and ICROFS. The CROPSYS and previous projects have maintained the unique long-term crop rotation experiment at three sites (CRO experiment), of which one of the sites will be continued in HighCrop. The large database from CROPSYS will together with data from other projects (e.g., BIOMAN, WEEDS and BIOCONCENS) be used for deriving models and concepts in WP2 for improved nutrient (N) management through targeted recycling of on-farm resources and by improved use of preventive (and cultural) measures for controlling perennial weeds. Information on effects of cropping practices on product quality will mostly be taken from previous national and EU projects (e.g., ORGTRACE, AgTechOrg, NIMAB, QILF) and incorporated into the project through the product chain workshops. Some of these projects have used material from the CRO experiment used in HighCrop. HighCrop also makes strong use of results from previous EU projects focusing on GHG emissions from agriculture, including NitroEurope, in which measurements of N fluxes and N2O emissions from the CRO experiment was made and compared with measurements from other European crop management systems. The development of IT planning tools will build on spreadsheet tools developed at VFL in the public funded project "Management and promotion of productivity". The activities in WP6 on barriers implementing novel systems for higher productivity will use information from the ongoing project at ØL on "Improved yields", where background information on this issue is being collected.

A13. Tables with milestones and deliverables with information as requested in the table in A16.
See Table in A16

A14. List of deliverables from the project (also fill out the table in A17)

See Table in A17

A15. List of appendices

Appendix A1. List of references
Appendix A2. Full list of person involvements (the form does not allow all to be shown)
Appendix A3. CVs of project leader and key team members

A16. Milestones and time schedule for the entire project

wp no.	Milestone no.	Title/activity	Responsible project participant	Date/year	Other participants
1	1.1	Annual meetings	JPM	Every year	All
1	1.2	Stakeholder/chain meetings organised	JPM	Every year	ØL
1	1.3	Project website etablished	JPM	03.2011	
2	2.1	1st version of N recycling/use model	JPM	01.2012	
2	2.2	1st version of perennial weed model	PBS	03.2012	
2	2.3	Revised N and weed models	JPM	10.2013	PBS
3	3.1	Additonal suction cups installed	JPM	04.2011	
3	3.2	All crop production data available	JPM	10.2013	PBS
3	3.3	N2O emission data processed	JPM	10.2012	
3	3.4	Biodiversity analyses completed	JPM	04.2012	
4	4.1	Mobile manure exp. completed	JPM	02.2013	DTU
5	5.1	Design of field experiments finalised	VFL	02.2012	
6	6.1	Perceived barrier interviews done	JPM	09.2011	ØL
6	6.2	Experienced barrier interviews done	JPM	09.2012	ØL
6	6.3	Stakeholder workshops completed	JPM	11.2012	ØL
7	7.1	Prototype rotation planning tools	VFL	04.2012	
7	7.2	Finalised planning tools	VFL	11.2013	
8	8.1	Field days for organic advisers	VFL	2012+13	
8	8.2	Open days and machine demo at farms	VFL	2012+13	
8	8.3	Planning tool courses for advisers	VFL	2012+13	
8	8.4	Product chain workshops reported	ØL	2012+13	

A17. List over deliverables (D=deliverables) for the entire project, stating whether the deliverable belongs to the research part of the project (R); the development part (D); and/or demonstration (Dm).

D. no.	Deliverable	Responsible project participant	Date/year	R, D, or Dm Effective working time, months [1]	Type of deliverable*
1.1	Progress/final report	JPM	03.2014	R: 3.0	P1
1.2	Product chain briefs (with WP8)	JPM	2011-13	R: 2.1	P1
2.1	Paper: N management model	JPM	11.2013	R: 12.3	S1
2.2	Paper: Perennial weed management	PBS	12.2013	R: 5	S1
3.1	Paper: Robust arable cropping systems	JPM	12.2013	R: 13	S1+S4+P1+P2
3.2	Paper: N2O emissions in cropping systems	JPM	04.2012	R: 8.8	S1
3.3	Paper: N losses and use efficiency in cropping systems	JPM	12.2013	R:9.1	S1+S4+P1
3.4	Paper: Soil biodiversity	JPM	02.2013	R: 7.5	S1+P1
4.1	Paper: Management of green manures	JPM	08.2013	R:7.4	S1+S4+P1
4.2	Paper: GHG from green manure treatment	JPM	10.2013	R:7.3	S1+S4
4.3	Paper: N-use in mobile green manure	JPM	10.2013	R:10.1	S1+P1+P2
5.1	Results published in Oversigt over Landsforsøg	VFL	2012-13	Dm: 4.4	P1
5.2	Summarising presentations of exp.	VFL	12.2013	Dm: 1	P1+P2
6.1	Farm and chain barrier report	JPM	10.2011	R:4.3	S2
6.2	Paper: Potentials for robust systems	JPM	10.2012	R: 4.6	S1
6.3	Paper: Co-evolution of high yield and robust systems	JPM	12.2012	R:3.5	S1+P1
7.1	Web-based crop planning tool	VFL	11.2013	D:3	C6
7.2	Farm decision tool	VFL	11.2013	D:3	C6
7.3	Paper: Planning and decision support	VFL	11.2013	D:3.5	P1+P2
8.1	Demonstrations, courses, workshops	VFL	2011-13	Dm:11.0	P2
8.2	Recommendations from training	VFL	11.2013	Dm:3.7	S2+P1

* Fill in the type of deliverable. Use the List of type of deliverables on the last page in Annex 3 “Instructions for filling in the application form”.

[1] The total amount of months must be consistent with the total number of months in the budgets, and will therefore show the relative working effort per work package.