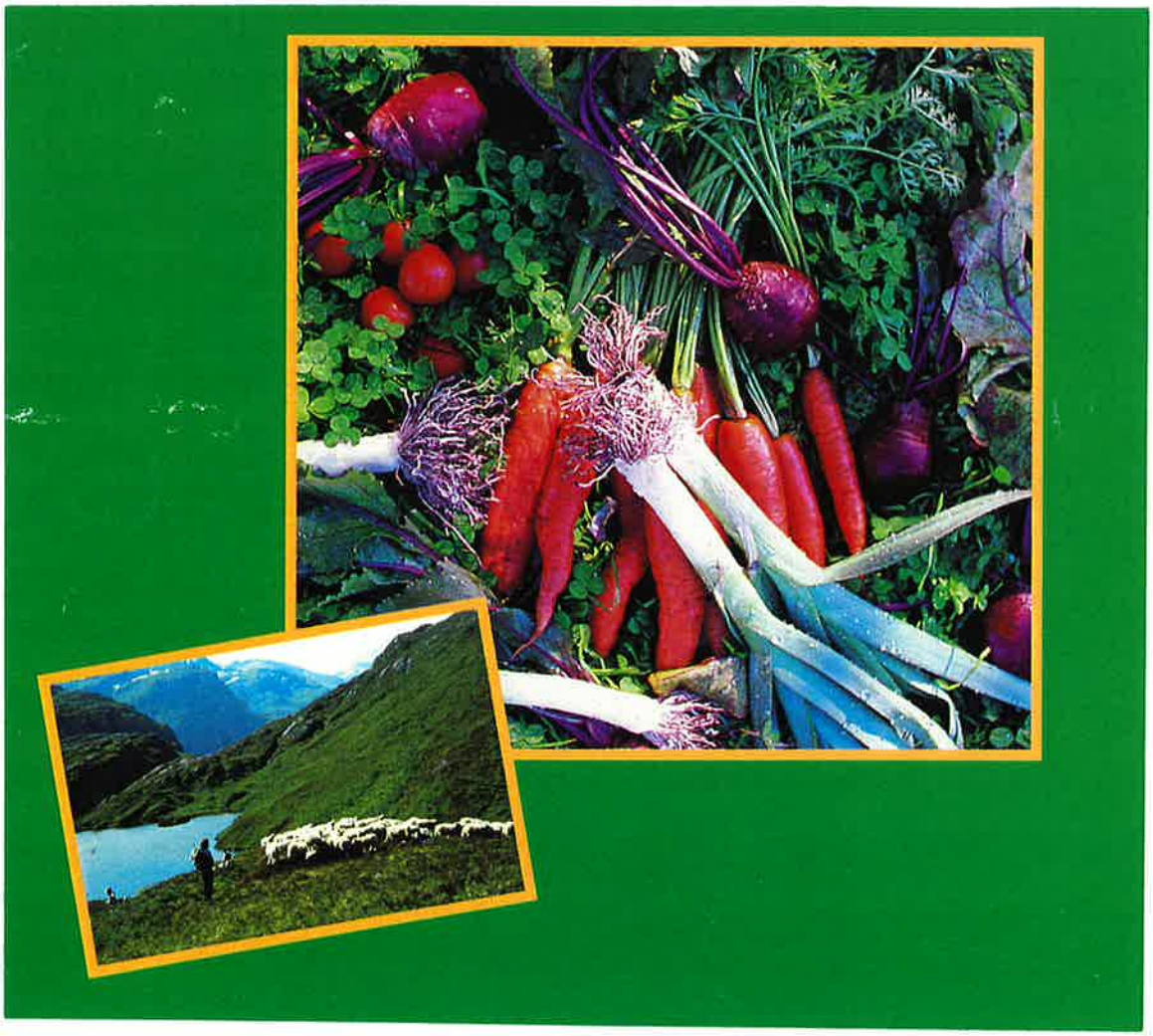
Evalueringsseminar
om
gårdsstudier i økologisk landbruk



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Innhold

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Forord

I regi av Forskningsutvalget for økologisk landbruk arrangerte Norsk senter for økologisk landbruk og Norges Landbrukshøgskole et seminar for å evaluere gardsstudier som metode. Seminaret ble avholdt på NLH-Ås 28.4.1998 og samlet omlag 30 deltakere.

Norsk senter for økologisk landbruk har gjennomført to gårdsstudieprosjekter: "30 bruks-prosjektet" i tida 1989-1993 og "Agronomi og økonomi i økologisk landbruk – 13 gårdsstudier" i tida 1993- 1997. Begge disse prosjektene ble finansiert med midler bevilget over jordbruksavtalen. Forskningsprogrammet innen økologisk landbruk ved Norges Landbrukshøgskole gjennomførte gardsstudier på sju gårder i tidsrommet 1990 – 1992. Institutt for plantefag har siden 1994 stått for prosjektet "Utvikling av økologisk og bærekraftig landbruk i typiske åkerbruksdistrikter". Prosjektet finansieres med jordbruksavtalemidler og avsluttes i 1998.

Gårdsstudier som arbeidsmetode ligger godt til rette for forskning innen økologisk landbruk, ikke minst fordi en her tilstreber en helhetlig arbeidsmåte, noe som også kjennetegner tankegangen bak denne driftsformen. Gårdsstudier trekker også menneskene på garden inn som en viktig faktor for målsetting og resultater.

Gårdsstudier er en ressurskrevende arbeidsform, og passer ikke for alle forskningsspørsmål som det er viktig å belyse. Forskningsutvalget for økologisk landbruk ønsket å belyse ulike sider av gårdsstudier som metode gjennom et seminar. En slik oppsummering er viktig med tanke på vurdering av framtidige arbeidsmåter innen forskning i økologisk landbruk.

Det er liten tvil om at gårdsstudiene som har vært gjennomført i Norge har hatt stor betydning for utviklingen av økologisk landbruk i Norge, samtidig som det er høstet verdifull erfaring og kompetanse er bygd opp på denne typen arbeidsmetodikk. Samtidig er det klart at en videre framgang innen økologisk landbruk er avhengig av kunnskap både om enkeltelementene i produksjonssystemene og helheten. Det vil således være behov for å nytte både reduksjonistiske og systemorienterte forskningsmetoder.

Tingvoll, september 1998

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Kvifor systemforsking?
Dette må truleg sjåast i historisk samanheng. Det siste århundre har vore prega av den industrielle utviklinga, og landbruket er her ikkje noko unnatak. Frå eit landbruk som i stor grad var basert på balanse innafor garden, og produksjon i høve til dette, har vi fått eit landbruk med stor vekt på å optimalisere produksjonen basert på importerte innsatsfaktorar. Dette har gitt stor produksjon av etter måten billeg mat, men etter kvart har ulempene med denne type landbruk kom i dagen, gjennom t.d. forureining, pressa økonomi og uttynning av folkesetnaden og det sosiale miljøet på landsbygda. I dei seinare åra har det òg vorte stilt spørsmål ved kvaliteten av maten i industrijordbruket. Ein kan sei at økologisk landbruk har utvikla seg som eit svar på mange av desse problema, og kanskje vil omlegging til økologisk eller miljøtilpassa landbruk føre oss over i ei ny stor omveltingsfase i landbruket.

Forskinga i «industriperioden» har i stor grad hatt som mål å maksimere utbytte gjennom utvikling av kjemiske innsatsfaktorar og metodar for bruk av desse. Ein har fokusert på effektar av ein eller eit avgrensa tal faktorar heller ein heilskaplege effektar. Med innføringa av økologisk landbruk vert fokuset innan jord- og plantekulturforskinga vendt frå kjemi til biologi, gjenbruk får større vekt enn forbruk, miljø- og matkvalitet vert sett i fokus og sist men ikkje minst så vert landbruks- og bygdebefolkningen sine levekår oppgraderte. *Heilskapen og samanhengane mellom dei ulike elementa får i det heile større plass enn i tradisjonell landbruksforsking.*

Det ville nesten vera rart om så store endringar i produksjonsmåte ikkje skulle gi trong for nye forskingsmetodar. Når eg har presentert dyrkingssystemforskinga på Apelsvoll, har eg brukt å sei at forskinga i alle fall må vera av ein tre-trinns-rakett: 1) tradisjonell forskingsmetodikk som gir kunnskap om einskildelementa i systema, 2) modellforsøk og modellering der ein måler heilskaplege verknader av eit begrensa tal faktorar og 3) gards- eller case-studiar der ein undersøkjer, beskriv og utviklar reelle driftssituasjonar i landbruket. Det er den siste metoden som er dagens emne, og eg skal ikkje gå vidare inn på dette no.

Som vanleg, var vi litt etter vår naboar i sør med denne type forsking, men NORSØK såg ganske tidleg (1988) dei moglegheitene som låg i gardsstudiar som metode til både 1) å lære om økologisk landbruk sine moglegheiter og begrensingar under våre driftstilhøve, 2) for å utvikle økologisk landbruk vidare og 3) som demonstrasjonsgardar for økologisk landbruk. NORSØK har gjennomført to gardsstudieprosjekt, 30-bruksprosjektet og Gardsstudieprosjektet. I kjølvatnet av dette starta NLH sitt Åkerbruksprosjekt for «Utvikling av økologisk og bærekraftig landbruk i typiske åkerbruksdistrikt». NLH har òg vore ansvarleg for Nordiske forskarkurs i systemforsking i landbruket.

Noregs forskingsråd har løyvd kr 80.000 til avsluttingsseminar for forskingsprogrammet i økologisk landbruk. Desse midlane er brukte til 'Informasjonsmøte i økologisk landbruk' som vart arrangert på Elverum den 26.-27. november 1997, og til dette seminaret, som skal oppsummere erfaringane med gardsstudiar så langt, med vekt på metodiske spørsmål: T.d. kva har gardsstudiane gitt, kva har dei ikkje gitt, kva problem har dukka opp, kva slag spørsmål kan løysast med gardsstudiar og framtida for denne type forsking.
Vi håpar no å få ei god meiningsutveksling og mest mogleg konkrete svar på desse spørsmåla.

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Gårdsstudier i økologisk landbruk

Erfaringer og blikk framover

Storparten av midlene til forskning i økologisk landbruk i Norge i de siste 10 år har gått til forskjellige former for gårdsstudier. Hva har vi lært av gårdsstudiene, og hvilken rolle kan gårdsstudier spille framover i forskningen i økologisk landbruk?

I det følgende vil vi gi en punktvis framstilling av våre erfaringer etter 9 år med gårdsstudier innen økologisk landbruk ved Norges landbrukshøgskole. På dette grunnlag ser vi så framover mot mulige framtidig anvendelse av gårdsstudier.

Våre erfaringer med gårdsstudier i økologisk landbruk

Disse erfaringer baserer seg på våre arbeider med gårdsstudier i økologisk landbruk siden 1989, innen rammen av de følgende prosjekter:

NLHs forskningsprogram i økologisk landbruk (1989 - 1994); Utvikling av økologisk landbruk i typiske åkerbruksdistrikter (Åkerbruksprosjektet) (1994 - 98); Beslutningstaking i økologiske produksjonssystemer (1994 - 98)

- *Gårdsstudier er ikke noe mål i seg selv, men er avhengig av de spørsmål som forskeren stiller. Når gårdsstudier brukes som metode i økologisk landbruk, er det et krav at problemstillingene må være relevante for utviklingen av økologisk landbruk*

I våre gårdsstudier i de siste år har følgende problemfelt for utviklingen av økologisk jordbruk i Norge stått sentralt:

Økningen i økologiske arealer finner nesten utelukkende sted for engvekster. For andre vekster er det en svært svak økning, og for noen vekster sågar en tilbakegang. Dette må sees i relasjon til den almene situasjon i det norske jordbruket, hvor det er sannsynlig at husdyrproduksjonen må senkes, og i forhold til økologisk jordbruk generelt, hvor allsidighet betones.

Det at nærmest utelukkende engarealer øker, medfører at det er lite vekstskifte i økologisk jordbruk i Norge, og det produseres lite planteprodukter for direkte salg. Når økologisk jordbruk kan klare seg med så liten grad av vekstskifte - som i all litteratur betegnes som bærebjelken i økologiske produksjonssystemer - så må det skyldes enten at tiltroen til vekstskiftevirkninger er overdrevet eller at offentlige betingelser er så gunstige at det selv uten den nevnte bærebjelken er mulig å overleve med en økologisk driftsform. Det lave nivå av planteprodukter for direkte salg er betenkelig av to grunner:

For det første fordi det norske økologiske jordbruket dermed ikke er i stand til å imøtekomme forbrukernes ønsker. For det andre fordi en høy grad av husdyrproduksjon betyr en lav matproduksjon per arealenhet, noe som er negativt i et matforsyningsperspektiv.

Den svake økning for åkerbruksvekstene er koblet til en svak utvikling av økologisk jordbruk i åkerbruksdistrikter, sett i forhold til økningen i husdyrbruk-distrikter. Dette problemfeltet var utgangspunkt for Åkerbruksprosjektet. I dette arbeidet var ikke vår oppgave å løse dyrkingstekniske spørsmål mht. enkeltvekster. Vår oppgave har mer vært å se på spørmål som

vedrører hele produksjonssystemet (Lieblein et al. 1997), med følgende utgangspunkt: Et visst husdyrhold er viktig i et økologisk driftsopplegg. En forbedret utnytting av gårdens egne arealbaserte ressurser (jord) vil føre til at en bestemt mengde husdyrprodukter kan produseres utfra et mindre areal. Derigjennom frigjøres arealer til produksjon av matvekster. Gårdsstudier har stått sentralt i dette arbeidet, fordi spørsmål som berører hele produksjonssystemet og ressursutnytting i gårdens produksjon som helhet ikke lar seg besvare gjennom bruk av tradisjonelle eksperimenter.

- *I gårdsstudier er det viktig å gjøre et bevisst og konsekvent valg av oppløsningsnivå for undersøkelsene, samt å avklare om det skal arbeides med regnskaps- og/eller prediksjonsmodeller*

I Åkerbruksprosjektet startet vi med intensjonen om å bidra til etablering av et bredt samarbeid i åkerbruksdistriktene; hvor forskjellige forskningsinstitusjoner, fylkesmannens landbruksavdeling (fylkene i åkerbruksdistriktene), økologiske forsøksringer og økologiske gårder kunne samarbeide. Det viste seg tidlig i prosjektet at det å etablere og vedlikeholde et slikt samarbeid ville kreve større ressurser enn hva prosjektet disponerte, og denne delen av arbeidet ble derfor trappet ned.

Det sentrale spørsmål i prosjektet har vært: Hvor lavt er det mulig å gå med husdyr i økologisk drift? Utnytting av gårdens arealgrunnlag som helhet har vært viktig i denne sammenheng. Bakgrunn for utvikling av et dataprogram for biologisk gårdsregnskap har vært at slike beregninger er så kompliserte at de vanskelig kan la seg gjennomføre på annet vis.

I vår modellering har vi arbeidet med både prediksjons- og regnskapsmodeller.

Vi har i første omgang sett bort fra næringsbalansen på gården. Avlingsnivåer og deres utvikling over tid er betraktet som viktigere.

Vi har også sett bort fra bruttoavlinger i fôrvekster. En kartlegging av disse er svært ressurskrevende. I tillegg har vi vært interessert i å utvikle analyseverktøy som kan tas i bruk på gårdsnivå. Dersom dette skal være mulig, må antall og omfang av registreringer begrenses.

Vi har således ikke tatt hensyn til avlinger på de enkelte skifter, men underordnet dette avlingen i sum for alle skifter.

Som en planleggingsmodell er ikke prediksjonsmodellen laget for å gi detaljerte svar om driften i framtida, men for å gi et overordnet bilde av hvor gården kan tenkes å havne, produksjonsmessig og økonomisk sett, etter endt omlegging (Breian og Lieblein 1995)

- *Systemtenkning og systemanalyse utgjør viktige grunnlag for gårdsstudier*

I systemforskningen forsøker en å ta inn mer av helheten i en situasjon, om det dreier seg om gårdsdrift eller andre forhold (Wilson 1992). Dermed blir det mulig å undersøke samspill mellom de enkelte deler av gården, og å studere emergente egenskaper av gårdssystemet.

Modellutvikling utgjør en viktig del av systemforskningen. En modell er

> *... the explicit interpretation of one´s understanding of a situation, or merely of one´s ideas about that situation. It can be expressed in mathematics, symbols or words, but it is essentially a description of entities, processes or attributes and the relationships between them. It may be prescriptive or illustrative, but above all, it must be useful (Wilson 1992).*

I Åkerbruksprosjektet arbeider vi med to hovedmodeller; en for hele gården, som betoner samspillet mellom agronomiske og menneskelige forhold, og en modell for produksjonssystemet på gården. Denne siste modellen danner grunnlaget for utvikling av et dataprogram for *biologisk regnskaps- og budsjettføring*. Modellene er beskrevet av Lieblein et al. (1997).

- *En gårdsstudie er en case-studie av en gård. I gårdsstudien undersøkes en gård slik den framtrer i sin natur- og samfunnsmessige sammenheng*

Case-studier er spesielt fordelaktige i situasjoner hvor

> *...a how or why question is being asked about a contemporary set of events, over which the investigator has little or no control (Yin 1989).*

Sentrale spørsmål vedrørende utvikling av økologisk landbruk har med hele produksjonssystemet å gjøre. Eksperimenter alene er ikke i stand til å svare på disse spørsmål, de er ikke i stand til å gi den nødvendige kunnskap, fordi eksperimenter kun kan belyse relativt enkle årsaks-virkningsforhold på et lavt systemnivå..

Case-studien derimot muliggjør en forklaring av *komplekse årsaks-virkningsrelasjoner,* fordi den gir anledning til å undersøke og delvis prøve ut hvordan mange ulike variabler samvirker. Gårdsstudier gjør det mulig å studere slike ulike relasjoner under forskjellige natur- og driftsmessige betingelser.

Case studier gjør det mulig å bruke ulike typer empirisk materiale, både kvantitative og kvalitative data (Østergaard og Lieblein 1994), case-studier gir anledning til å studere utviklingsforløp over tid (longitudinelle studier), og case-studier gir gode muligheter til læring (Bakke og Strøm, 1998).

Resultater av case-studier kan generaliseres på samme måte som resultater av eksperimenter. Case studier

> *...like experiments are generalizable to theoretical propositions and not to populations or universes. In this sense, the case-study, like the experiment, does not represent a sample, and the investigator´s goal is to expand and generalize theories (analytical generalization) and not to enumerate frequencies (statistical generalization) (Yin 1989).*

Det betyr at erfaringer fra gårdsstudier kan sies å ha gyldighet eller relevans for andre gårder som har vesentlig felles systemtrekk.

Gårdsstudier gir i seg selv ikke nødvendigvis en helhetlig beskrivelse av den undersøkte gård, heller ikke når kvalitative data brukes. Gårdsstudien kjennetegnes ved at det er gården selv som danner ramme for diskusjon og analyse av datamaterialet.

- *Arbeid med gårdsstudier betyr ikke bare å ta i bruk en ny forskningsmetode, men også en mental omstilling: Fra del til helhet.*

I samspill med utviklingen i landbruksnæringen har landbruksforskningen blitt sektorisert. Testing av forskjellige agronomiske tiltak i deler av produksjonssystemet har stått sentralt. Faktorielle ruteforsøk har dominert planteforskningen. Denne tilnærming har gitt framskritt mht. de variabler som er valgt for å evaluere virkning (kg/daa, l/årsku), men ikke for produksjonssystemet som helhet (Lieblein et al. 1997). Forskningen har mistet grepet på produksjonssysemtet som helhet. I praksis er det helheten som er det avgjørende, fordi bondene lever ikke av sine enkelte vekster eller dyr, men av det gården produserer i sum. Grunnlaget for den ensidighet som har utviklet seg er troen på at en forbedring av de enkelte deler automatisk fører til en forbedring av helheten, eller summen.

Arbeid med gårdsstudier innebærer derfor en grunnleggende mental omstilling; fra å forsker på enkeltområder, til å forske i helhetlige samspill.

• *Gårdsstudien kan gi ulike typer kunnskap ettersom hvilket forskningsdesign som anvendes.*

Gårdsstudien kan i hovedsak ha tre ulike funksjoner (etter Kjellén og Södermann 1980): Den kan for det første være en *illustrasjon* ved å vise til hvordan en gård fungerer i praksis under ulike klimatiske, agronomiske og sosiale betingelser. Den kan for det annet være et hjelpemiddel ved *hypotesegenerering* gjennom å utforske og beskrive et ukjent felt eller å produsere mer fruktbare innfallsvinkler til områder som allerede er godt kjent. Og den kan for det tredje *generere ny forståelse* gjennom - på grunnlag av en beskrivelse av det studerte fenomen - å søke å forklare komplekse sammenhenger. Våre gårdsstudier har i hovedsak vært å finne i den siste kategorien. Gjennom dybdestudier av seks gårder over en fireårsperiode har Åkerbruksprosjektet tatt sikte på å generere ny kunnskap om det mangefasetterte samspillet mellom gårdens ulike ledd - jord, plante, dyr - og mellom gård og menneskene under omstilling til økologisk landbruk.

• *Spørsmålet om hvilke slutninger en kan trekke av en gårdsstudie avhenger i mindre grad av at det er en gårdsstudie enn hvordan gårdsstudien gjennomføres . Videre kan man først snakke om almene resultater av en gårdsstudie når resultatene finner gehør i omgivelsene.*

Case-studien er undervurdert som kilde for ny kunnskap (Flyvbjerg 1991). Innvendingen har vært at en gårdsstudie kun gir kunnskap om den studerte gården og at den ikke gir almen kunnskap. Når det rettes kritikk mot gårdsstudiens manglende grunnlag for å trekke generelle slutninger, går man ofte implisitt ut fra at nettopp dette er mulig i eksperimentet eller i utvalgsundersøkelsen. Men også i eksperimenter er det nødvendig med flere gjentak for å kunne si noe sikkert om et årsaksforhold (Yin 1989). Også i utvalgsundersøkelsen er det ikke uten videre gitt at man kan dra slutninger for hele den populasjonen som utvalget er en del av (Kjellén og Södermann 1980).

• *Gårdsstudiens fortrinn er den dybde den gir av det studerte fenomen. Den fører inn i komplekse og ofte uoversiktlige sammenhenger i det virkelige liv.*

Gårdsstudien rommer muligheten av dybde og deltagelse, muligheten til å utforske virkeligheten i dets dybde og kompleksitet. Som Flyvbjerg (1991) peker på, er for forskere casestudiens nærhet til virkeligheten og den mangfoldige detaljerikdom viktig av to grunner:

> *For det første for udviklingen av en nuanceret virkelighedsoppfattelse (...). For det andet er cases vigtige for forskerens egen læreprosess. Hvis forskeren ønsker å utvikle sine færdigheder som forsker til et højt niveau, er konkret kontekstafhengig erfaring lige så central som ved indlæring af en hvilken som helst anden færdighet.*

Bruk av gårdsstudier i framtidig forskning i økologisk landbruk

• *Gårdsperspektivet*

Hovedutfordringen i åkerbruksdistriktene består i å ivareta den jordbruksmessige karakter til disse områder - dvs. produksjon av åkerbruksvekster -, men med et nødvendig minimum av husdyrhold som grunnlag for vekstskifte og allsidighet i produksjonen. En viktig forskningsoppgave vil her bli å belyse forskjellige nivåer av husdyrhold og hvilke konsekvenser dette vil få for ressursutnytting og økonomisk utbytte. Hvor få husdyr kan en klare seg med i åkerbruksdistriktene?

Hovedutfordringen i husdyrdistriktene er knyttet til spørsmålet om å inkludere vekstskifte og allsidighet i produksjonen. I hvilket omfang er det mulig å drive med åkerbruksvekster i disse områdene? Ressursutnytting, matforsyning og økonomi vil her være viktige felter.

De ovennevnte problemstillinger omfatter komplekse årsaks-virkningssammenhenger, og kan derfor ikke i tilstrekkelig grad avklares gjennom tradisjonelle eksperimenter.

Gårdsstudier vil derfor i stadig større grad bli et viktig redskap i forskningen i økologisk landbruk. Gjennom gårdsstudier kan produksjonssystemenes emergente egenskaper (Odum 1983) undersøkes.

• *Det regionale perspektiv*

Perspektivet på økologisk jordbruk må snarest flyttes ut over den enkelte gårds grenser, både i praksis og forskning. Dette fordi utfordringer i årene som kommer ikke bare har å gjøre med den enkelte gårdsdrift. Hele matvaresystemet vil i stadig større grad bli viktig for alle bønder, og kanskje i særlig grad for dem som driver økologisk. Bonden må spille en mer aktiv rolle i matvaresystemet enn hva som har vært tilfelle fram til nå. Det må etableres nye relasjoner mellom de forskjellige aktører i matvaresystemet: Bonde, foredler, omsetter, forbruker og avfallshåndterer. En strategi for jordbruket framover kan være å øke verdiskapingen på gården, gjennom foredlingsvirksomhet, lokal omsetning av produkter etc.

Vi mener at det er åpenbart at på det regionale nivå er tradisjonelle jordbrukseksperimenter alene ikke i stand til å fange opp det vesentlige i situasjonen.

For å arbeide forskningsmessig på dette nivå vil case-studier av forskjellig art være viktige, f.eks. gjennom etablering av pilotregioner eller pilotkommuner

• *Utdanningsperspektivet*

Det er en viktig oppgave for landbruksforskningen å knytte forskning nærmere til utdanning, både på kandidat-, etter-, og videreutdanningsnivå. Dette gjelder også for økologisk landbruk.

Utdanning i økologisk landbruk/agroøkologi møter denne utfordringen med å formidle et tverrfaglig felt. Agroøkologien søker å trekke sammen kunnskap fra en rekke disipliner og anvende den tverrfaglige kunnskapen i en analyse av hele gårdssystemet (Lowrance et al. 1984). Denne intensjonen har gjort det agroøkologiske perspektivet særlig relevant for forskningen i økologisk landbruk (Altieri 1995).

Arbeidet med å etablere agroøkologi som et nytt undervisningsfag representerer både en faglig og en pedagogisk nyvinning; *faglig sett* fordi det i dag er liten erfaring med tverrfaglig forskning og undervisning i agroøkologi, og *pedagogisk sett* fordi et slikt tverrfaglig siktemål som agroøkologien har, gjør det nødvendig med nye måter å formidle kunnskap om landbruk og miljø på. Det som trengs utviklet, er en mer helhetlig forståelse av hvilke konsekvenser agroøkologiens fagovergripende ansats får for undervisningen i agroøkologi. Denne agroøkologiske undervisningen vil befinne seg i et skjæringsfelt mellom kunnskap om agroøkosystemet (praksis) og agroøkologisk forskning.

I denne sammenheng kan case-studier/gårdsstudier danne en helt avgjørende forbindelse til praktisk jordbruk ved for det første å vise hvordan de ulike fagene er sammenvevd i konkrete situasjoner, på konkrete gårder med konkrete mennesker; for det annet kan gårdsstudiene danne en ramme for studentenes egne tverrfaglige prosjektarbeider. Case-metoden sikter mot å utvikle en rik kontekstviten hos studentene, og et engasjement og en erfaring, som er nødvendig for å bli ekspert på landbrukets område. Nettopp derfor er metoden sterkere som læreredskap enn de i hovedsak teoretiske, didaktiske metodene som preger dagens læreboksundervisning.

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Long-term case studies and surveys on Norwegian eco-farms

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Introduction

A combination of case studies and a survey was used in two projects to develop ecological agriculture in Norway and to establish a base of knowledge on this farming practice. The conversion process and other developments on the farms were studied from 1989 to 1996. The researchers were active in giving advice during the conversion process, and a method for conversion planning was developed in cooperation with local advisers in ecological farming. Case studies and close cooperation among farmers, researchers, and advisers fit well into the holistic philosophy of ecological agriculture (Løes 1990).

Research strategies and project design

Scientists have four different research strategies available: experiments, surveys, archival analysis and case studies (Yin 1989, cited in Lieblein&Østergaard 1993). Case studies have not been used frequently in agricultural research in Western countries, but they have been useful in introducing new farming techniques in developing countries (Chambers 1993). Several case study projects going on in Norway, Denmark, and the United Kingdom, for example, are a sign that this research strategy is valuable for developing new farming practices in industrialised countries also.

At NORSØK we studied 36 farms spread all over Norway in a project that ran from 1989 to 1992, and studied 13 of these farms further in a second project from 1993 to 1996. With respect to the four research strategies, the make-up of our projects has been approximately 60% surveys, 30% case studies, 7% archival analysis (that is, reading scientific publications) and 3% experiments. Results from the main survey part of the projects are presented in other papers (Strøm & Olesen 1997, Vittersø 1997, Løes & Øgaard 1998), so this paper will concentrate on case study experiences.

To establish a base of knowledge about ecological farming under the conditions prevailing in Norway, we collected results in a broad survey of ecological farms covering crop production, milk yields, economics, soil nutrients, etc. The farmers and the project staff kept detailed records on several items that are not described further here. In the case studies, the results from each farm were described and assessed to find interesting connections.

The first project started very rapidly, without much time for detailed planning. When the number of farms went down from 36 to 13 in the second project, we overestimated how much the work would be reduced. As a consequence, project plans were too ambitious. In the first project, the number of project leaders varied between two and four, and we cooperated with advisers in ecological agriculture and with several research institutes. The second project was designed to have less administration and more research work for the 3,8 project leaders (3 working full time and one working 80%). Each project leader was responsible for three or four farms and one of four subjects: nutrient cycling, plant production, animal husbandry, and economics. Each project leader contributed his or her knowledge of a particular farm in a group effort when the case study was written. Successful cooperation requires a good deal of time, but the interdisciplinary work resulted in very interesting descriptions of the participating farms.
Norway is sparsely populated, and travelling to visit the project farms was very time-consuming. In the first project the project leaders made annual visits to the farms they advised. The other farms

were visited only once. In the second project, each project leader made twice-yearly visits to the farms she or he advised, and the other project leaders joined the farm visits when necessary.

Human case studies

Case studies are frequently used in human disciplines such as medicine and psychology. A paper describing a case usually has a framework consisting of an introduction with details such as the subject's age, education, and family situation. Then the problem of the case and the therapy that was used are described. Finally the paper reports the results obtained in this case.

Farming is a human activity with many interactions between human qualities such as skill and motivation, on one hand, and natural resources such as soil and animals on the other. The human part of a farming system is essential in determining the degree to which the system succeeds. Case studies are based on the fact that each case is individual and unique. Therefore this research strategy, probably better than any other, can handle different human qualities and their strong impacts on the success of the farming system.

Whole farm case studies

Framework

Five of the 13 farms are described in whole farm case study reports of 50-60 pages illustrated with photographs (Kolstad & Olesen 1996, Løes 1996, Birkeland & Vittersø 1997, Ebbesvik & Rosvold 1997, Vittersø 1997). In broad outline, these reports have the same framework as mentioned for the medical paper. The introduction describes the farm and farmer (climate, production, conversion strategy, motivation for ecological farming, etc.). The "problem" of the case was how the conversion proceeded, how the ecological farming system functioned, and eventually how the farmer made progress with his or her further plans for development on the converted farm. The "therapy" was personal advice, including planning of the conversion process and combined educational and motivational seminars for the farmers. The conversion plans (see below) were transformed to case study reports, with all relevant results from the record keeping presented. Interesting changes or other developments were commented upon. As a conclusion, the success of the farm was evaluated and compared with both the farmer=s goals and the goals of ecological agriculture. Also described were the farmer=s plans for further development of the farm, and suggestions for new or altered activities that might bring the farmer closer to his or her goals.

In addition to the whole farm case study reports, other farms were described with emphasis on single items in short papers published in different periodicals. Examples of such case study papers include a calculation of nutrient importation on a farm with very extensive animal husbandry, a description of the social aspects of biodynamic farming, and a discussion of how to produce milk successfully with fodder rations that are very low in concentrates. The papers are collected in a report (NORSØK 1997).

Personal advice

Each member of the project staff advised and made conversion plans for a group of farmers. In a conversion plan, different parts of the farming system must be balanced against each other; Figure 1 shows how the parts are closely linked. The amount of available fodder must be calculated, then the herd size that is suitable for this amount of fodder. After that, plans must also be made for further fodder rations, crop rotations, disposal of the manure, etc. It often is necessary to do these calculations several times to get both the plan and, hopefully, the farm well balanced.

The adviser should always be aware of the farmers goals. The goal is not always to enhance production. Commonly held goals among the farmers participating in the projects included the possibility of having more than one person working on the farm, a good quality of life, care of the landscape, and working for a more just and sustainable global situation. Advice was not given only on farm visits by a single project leader or local adviser. The seminars that were arranged contributed greatly to the conversion process and other developments on the farms.

Based on the conversion plans for the project farms, a method for conversion planning was developed in close cooperation with the most experienced advisers in ecological agriculture. This method was introduced in several workshops and seminars for farmers and advisers, and was published in a book (Løes et al 1994).

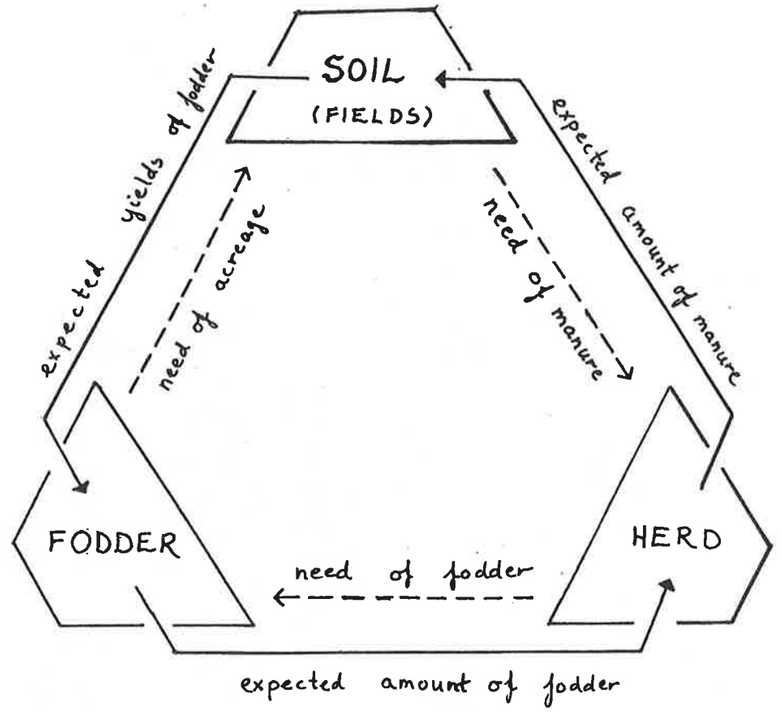

Figure 1. Soil, amount of fodder and herd must be in balance in ecological agriculture. Adapted from A. Hugo, 1993.

Seminars

The combined motivational and educational seminars for the farmers and project staff, including the local advisers, lasted from three to seven days and were held once a year. When possible, the farmers' families participated. At each seminar, some farmers described their farms and their life stories in speeches illustrated with slides. These were very exiting contributions, sometimes lasting for about two hours. In the first five years the seminars concentrated on agricultural themes such as crop rotation, care of the landscape, or weed control in carrots. In addition, there were evening lectures that were more political and philosophical. During the last three years the farmers preferred more inspirational lectures and did not want so much agricultural education. Staying together for almost a week each year brought them close to each other. They felt they were a team, and some farmers who were having difficulties with conversion were inspired to continue.

The seminars were important as a source of advice because the farmers learned from each other and from the people giving the lectures. Some activities they later introduced on their farms were partly the result of the inspiration provided by the seminars. For instance, several farmers have started keeping Old Norwegian breeds of milking cows; a very inspiring lecture about such breeds was given in 1990.

Farmers and project staff on the last seminar.

Contact and cooperation

Even with the intensified visits in the second project, visits twice a year often are not enough to get continuous information on what is happening on the farm. When the researcher stayed on the farm for a few days, such as to collect soil samples, much information was collected during meals and other social occasions. Compared with the visits in the first part of the project, which provided a good deal of information, the annual visits to walk over the fields with the farmer in summer and discuss the results of the record keeping in winter were of less value as the second project came to an end. Sometimes two or three project leaders visited a farm together, providing a good opportunity to see the farm with fresh eyes.

In the second project we introduced monthly telephone talks to keep in contact with the farmers. When there was something we had to discuss, such as farm nutrient budgets, the talks were very useful. Talks to collect general information, based on questions like "How are you, and how is the farm?" often provided less information.

The farmers have been somewhat critical of how the results are presented and used. On one hand they do not want these results to be taken as a guarantee to other farmers that conversion is the right solution, but on the other hand they want ecological farming to develop and grow. The project leaders and the farmers have had several discussions on how to present the data, and nothing gets published that the farmers have not first read and corrected. Farmers assessing conversion, advisers in ecological agriculture, and other researchers have been very interested in the project results.

The project leaders and farmers in the two projects have cooperated for eight years. This was fortunate because it is very interesting to follow the development of a group of farms for such a long time. When a project starts everybody has drive and enthusiasm, but this will slowly diminish. Case studies involve working with people, and when the project lasts for more than three or four years there will be some human wear and tear. The researcher should include this factor in project planning. Ordinarily, agronomists are not professionally trained to handle people, and cooperation with sociologists would have been useful. Sociologists from Centre for Rural Research at the University of Trondheim investigated the farmers' motivation and social barriers to conversion during the first project (Vartdal 1993), but they were not part of the project staff.

Informal information is basic when doing a case study of a whole farm, and this information is collected in the mind of the researcher. The researcher lacks tools to handle information about the farmer=s decisions, the social organisation of the farm, and so forth. Informal knowledge is difficult to transfer if the researcher quits, but is useful when researchers cooperate.

Conclusions

These case studies have lasted for eight years, and combined with the surveys have produced large amounts of data. It was very fortunate that the participating farms had different production systems, were located all over the country, were in different stages of conversion, and included both biodynamic and other ecological farms. Both the farmers and the project leaders learned a lot about farming practices in various climatic regions and in situations that varied in other ways. This is very valuable when the researcher is introduced to farmers and advisers that he or she has not met before, perhaps at a lecture or a new case study project.

Special circumstances probably led to the financial support of this project, because the government wanted to support the development of ecological agriculture in Norway, and case studies combined with surveys were a reasonable way to collect information and to inspire farmers to convert. But case studies need not last for eight years. Figure 2 shows different types of case studies. Our long-term combined case studies and surveys can be classified as detailed studies of demonstration farms. The information that was brought in from the case studies was very useful in the survey part of the projects.

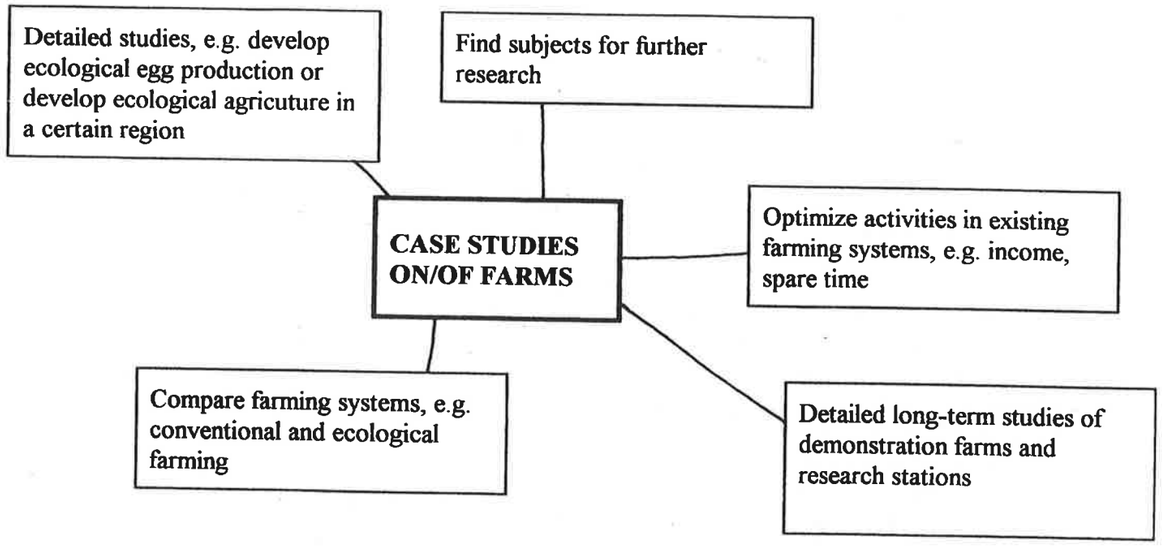

Figure 2. Different types of case studies on, or of farms.

Case studies fit well into the holistic philosophy of ecological agriculture. The results do not represent experimental conditions, but rather real farming practice. Such results are easily transferable to other farmers, and the researcher will be better qualified to ask reasonable questions and to decide which problems are most important to solve. It is convenient to have a large stock of good farm examples and to know farmers to discuss and cooperate with to develop sustainable farming practices further.

The case studies provided information on the most important barriers to conversion in different regions of Norway. This was very useful for shaping the Norwegian rules of certification, for example. Different adjustments to the certification rules and the consequences of such adjustments were described. This is useful in designing further subsidies for ecological farming.

Case studies provide a very favourable opportunity for interdisciplinary work. Several topics must be integrated to create a whole farm case study. A method for conversion planning was an important result of the project, and it is necessary to work in an interdisciplinary way to make a high-quality conversion plan.
It is obvious that the participating researchers, farmers, and advisers learned a lot from the case study work. The whole farm case study reports, the short papers describing interesting aspects of individual farms, and the published method for conversion planning ensure that other farmers, advisers, and researchers can share the knowledge gained from the case studies.

Agricultural scientists normally are not very well trained in treating farmers as their research material, and they also lack tools to handle informal information in a professional way. This shortcoming should be solved both by providing appropriate education for agricultural scientists and by having them cooperate with social scientists.

Case studies are effective in identifying questions for further research, and other research strategies often must be used to answer these questions. Hence, case studies cannot be the only research strategy in the development of ecological agriculture, but they can be a valuable part of it.

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A systems approach for assessing sustainability in livestock farms

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Summary

The concepts of sustainability is widely used in agriculture. There is, however, a large variability in the interpretation of the meaning of sustainability. The broad understanding in conjunction with the complexity of livestock farming calls for a systems approach.

In this paper different interpretation of sustainable agriculture is described and discussed. It is concluded that sustainable agriculture has a major normative dimension and obviously has different meanings for different groups in society. Using sustainability in a systems describing concept, one has to be very aware of the normative dimension.

With a starting point in farm models previously described in this journal a model is introduced where the farm is shown in the centre and put into perspective with other groups in the whole society. The other group represents different perceptions of sustainable agriculture. These perceptions might be in conflict with each other and/or with the observed farm. The idea is then to analyse and forecast in which direction the dominant perception of sustainability will be moving. It is suggested that this can be analysed be means of the discourse concepts which come from social science.

A key point in the model is that the farm is considered as a learning human activity system where the farmer reconsiders or reflects his current management in the light of the change in society. In Denmark the dominant perception of agricultural sustainability has changed towards the environmental issues during the last 20 years. As a consequence of this change different indicators have been developed for the purpose of describing and stimulating self reflection concerning environmental issues at farm level. These environmental indicators are presented and discussed through examples. Finally, an approach of including a variety of productions systems (i.e. both conventional and organic farming systems) in conjunction with researchers from a variety of disciplines is described.

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Introduction

During the last decade, sustainability has been on the agenda for many agricultural scientists. However, although the concepts of sustainability is widely used in agriculture there appears to be a large variability in the interpretation of the meaning of sustainability - also within animal production systems (Zijpp, 1993). Dunlap et al. (1992) have made an empirical examination of the understanding of sustainable agriculture among faculties and farmers in US, which shows a large variation of the understanding, in particular within the academic disciplines and between faculties and farmers.

The broad understanding in conjunction with the complexity of livestock farming calls for a systems approach for assessing the sustainability of livestock farms. In this paper sustainable agriculture is discussed with a starting point in farm models previously described in this journal. We are discussing the possibilities (or lack of possibilities) of making precise judgements as to whether a particular farming system is sustainable or not using different interpretations of the concept of "sustainability". Using examples from Danish agriculture and society we suggest how the sustainability at livestock farms might be assessed and further developed.

Interpretation of sustainable agriculture

Prior to the late 1970's the concept of sustainable agriculture was confirmed to few groups and organisations of alternative agriculture, i.e. organic movements (Buttel, 1993).

Increasingly, the environmental movements began to see the agricultural sector as being crucial for the environment. Environmental attention to agriculture began to accelerate during the 1980's both in US (Beus & Dunlap, 1990) and in EU (Michelsen, 1994).

The 1980's was also the decade when there were problems with overproduction and collapse of the export market. This led in US to a significant growth in farmers' interest in sustainable agriculture in terms of Low Input Sustainable Agriculture (LISA, Beus & Dunlap 1990). Also in EU there was a growing interest among farmers for sustainable agriculture although it started a few years later than in US.

Later in the 1980's, the debate about sustainable agriculture was highly stimulated by the so called Bruntland Report (1987 p43): *"A sustainable development is a development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs".*

There seems, however, to be major differences in the perception and understanding of what sustainable agriculture means. Based on a literature review, Douglass (1984) discerned between three different cases in which the term sustainable agriculture had been used:

1) Long term food sufficiency either domestic or world wide (food sufficiency).
2) An agricultural system which preserves and conserves renewable and non-renewable resources (stewardship).

3) A set of agricultural practices, which encourages certain virtues and undergirds the vitality of local communities to be preserved or reinstated (alternative agriculture).

According to Ruttan (1994) view 1) represents the mainstream agricultural community and economists. View 2) might represent the perspective of environmentalists and view 3) represents the perspectives of alternative agricultural groups like organic or biodynamic farmers.

Burkhardt (1989) discusses the morality behind sustainability with a starting point in the above mentioned perspectives. His conclusion is *"that our obligations to future generations entail sustaining more than just sufficient food production or an adequate resource base. Sustainability has to do with larger institutional issues, including our ability to incorporate our common morality democratically into our institutions, practices and technologies".*

Thompson (1992) argues that some common discrepancies between different notions of sustainability are related to the indiscriminate use of sustainability as 1) "a system describing concept" or 2) "a goal describing concept". He claims that, even when position 1 is taken, one should be very aware that a judgement of the sustainability of a system is in fact a normative claim. This is because the choice of indicators of sustainability itself is based on value judgements. Within position 2) Thompson discusses the problem of considering sustainability as an intrinsic value. Goals that are intrinsically valuable are goals that require no further justification. They are ends in themselves. Thompson (1992) found, however, that sustainability should not be considered as an intrinsic goal because one can suggest systems that one would not wish should last for ever (i.e. societies based on slavery). Therefore, he concludes, sustainability should be used as an add-on goal for systems that meet other desirable objectives.

In another paper Thompson (1997) discusses the varieties of sustainability with a starting point in the above mentioned perspective. He finds that the basic idea behind food sufficiency (perspective 1) is fundamentally different from the idea behind perspective 2 and 3. While food sufficiency is a matter of input/output relationship (resource sufficiency) the stewardship and alternative agriculture viewpoints are matters of reproduction of crucial elements in the system (Thompson, 1997). Thompson denotes this aspect as "functional integrity" and points out that the difference between environmentalists' and alternative agriculturalists' viewpoints relates to the different systems and systems attitudes on which they focus.

Thus, the term sustainability obviously has a different meaning for a farmer considering his possibilities to continue on his farm than for an environmentalist looking at the farm from outside or someone focusing on intensive farming systems in relation to other parts of society. Therefore, someone using sustainability as a system describing concept should be very careful to define that system, its borders and its interaction with the outside. Next, one has to be very explicit with defining whose goals or interests would be compromised if the system is not sustainable. This way it might be easier to agree on and understand the purpose of selected indicators of the (non)-sustainability of different farming systems.

Systems approach

Systems theory and systems thinking give a general frame work for the understanding and the communication of complex phenomena and problems seen in the real world. The purpose is to get an understanding of the observed system as a whole, through an identification and modelling of the different elements in the system. This implies a reduction and simplification of reality.

A basic motto in systems theory is that "everything is related to everything else". Thus, the reduction and modelling of the observed systems will depend on the eyes that observe reality and can always be discussed. By this, we mean that it is a normative task to define a system's borders and which of its relations to other systems that are important.

Because of their ability to create knowledge about complex problems, systems theory and systems thinking are good tools for assessing sustainability on livestock farms. However, one has to be very aware of the problems of dealing with fundamentally different conceptions of sustainability as mentioned in the previous section. In particular, it can be a problem if the scientist responsible for the system identification and modelling does not acknowledge the normative dimension of sustainability.

When studying agricultural systems, one must not overlook the important role of the farmer/farmer's family, their values and goals and their relations to others (colleagues, advisors etc.). Thus, Le Moigne's (1977) more narrow definition of a system as a goal seeking object is more appropriate when studying agricultural systems: *A system is an object in the surrounding world which guided by goals undertakes an activity and develops its internal structure through time without losing its unique identity* (Le Moigne, 1997, own translation). The importance of this definition is that it describes something that is at the same time active, stable and developing – all in a combined attempt to reach a certain goal (either consciously, instinctively or mechanically). This concept of a system means that the observer has to choose to focus on what the system does (the functional aspect), what the system is (the ontological aspect) or how it develops (the morphogenetic aspect). It is one of the strengths of systems theory to make this unavoidable choice more clear. Moreover, Le Moigne's definition of a system as a unit that seeks to keep its unique identity even if it adapts and undergoes a development, is analogous to Thompson's (1997) concept of functional integrity. Thus Le Moigne's system definition might be a good frame work for the analysis of the sustainability of agricultural systems from this point of view.

Sørensen & Kristensen (1993) give a general description of systems thinking and introduce a general model of a farm as a cybernetic system suitable for research. This model has been one of the cornerstones in Danish livestock farming systems research during the last 10 years.

The model of Sørensen & Kristensen (1993) discerned between the production system and the management system, thus acknowledging the idea of a farm as a goal seeking system. The model of the production system was quite simply only including well known elements such as different crops, animals etc. The management system was introduced as a black box and thereby indicating that no general model was found suitable. The normative part of the management system was not modelled at this stage. This model has mainly been used to study and mimic the production process at private farms. According

to the definition given by Bawden et al. (1984) this type of modelling can be classified as hard systems modelling and the normative dimension is only acknowledged through participation of farmers.

In the paper by Gibon et al. (1996) made by 6 scientists from 5 European countries, a common European model of a farm based on systems theory and thinking is introduced. This model includes the essential parts of the model by Sørensen & Kristensen (1993) and at the same time it is more explicit concerning the normative dimension. It represents the duality between the view of a farm as a human activity system (primarily functional and morphogenetic aspects) and the view of the farm as a production process (PP) (primarily ontological aspects).

The view of a farm as a PP focuses on the farm as a biotechnical system transferring physical input to physical output. The PP view gives good possibilities for operationalizing sustainable agriculture parameters concerning productivity and environmental effects of the livestock farm. However, traditionally the PP view has focused on production and output in terms of products and economy while externalities were not included.

In the view of a farm as a human activity system (HAS) the farmer (family) is seen as a person satisfying specific objectives through farming activities. In the HAS view the farmer uses information from the farm environment and the production system to make decisions concerning the biotechnical system in order to adapt the farming activities to his own objectives as well as to respond to pressures from the outside. Thus, the HAS view gives good possibilities for describing and analysing social values concerning sustainable agriculture and the communication process between the farmer and the society concerning adapting and developing sustainable agriculture activities.

The dual view on livestock farming, as in the model by Gibon et al. (1996), implies that sustainability is considered a normative or a goal describing concept. The problems, however, are firstly, whose norms or goals should be aimed at and secondly, how should they be implemented at the farm. As mentioned earlier there might be major differences in the view of what is sustainable or not. A conventional farmer has another view than an alternative farmer who again might have a different view from that of an environmentalist. Scientists, therefore, have to be very aware of which social values and institutional backgrounds their interpretation of sustainable agriculture is based on. This problem is not addressed in the paper by Gibon et al. (1996).

Figure 1 shows a model that represents the dual view of a farm (PP and HAS) in a similar way as in Gibon et al. (1996). The model is, however, extended to include different other groups in society which are supposed to have interests in farming systems, i.e. the market, conventional or organic farmer colleges, public authorities, environmentalists, advisors and farmers. All these groups are expected to have opinions about the meaning of sustainability in agriculture. The inclusion of these groups in the model in figure 1 illustrates the idea that the individual farmer/farmer's family probably does not develop his/its norms and practices (including their reaction to the sustainability issues) isolated from others. Some farmers more easily reflect on and react to changes in values and perceptions in (non-farmer-groups) society, while others to a larger degree conserve their

practices and exchange ideas between colleagues (Ploeg, 1990; Le Guen & Ruault, 1994; Noe, 1997). Moreover, analyses using the farming styles concept have demonstrated that farmers, though different, tend to group around certain value orientations (Ploeg, 1996; Noe, 1997).

Even if not all farmers can be expected voluntarily to pay much attention to issues of sustainability it can be argued that it is important for them to adjust at least partly in order to stay in business in the long run. Thus, in figure 1 an arrow around the farm symbolise that the farmer needs to reconsider or reflect his current management in the light of the change in the outside world. This understanding fits well in the theory of 2nd order cybernetics (von Foerster, 1992). A key point in figure 1 is that the farm is considered as a learning human activity system. Inspired by the theory of 2nd order cybernetics Thyssen (1992) writes the following concerning a systems learning process: *"It (the system) can observe that it is observed by other subsystems using criteria which are foreign to its own but which affects its autopoiesis. This means that the internal criteria of the subsystem have to be supplemented by external criteria. The result is that the subsystem becomes sensitive to hitherto unforeseen effects of its operations so that it might consider how to relate to e.g. threats of political intervention, scientific analysis of pollution or the consequences of its activities for the local community"*

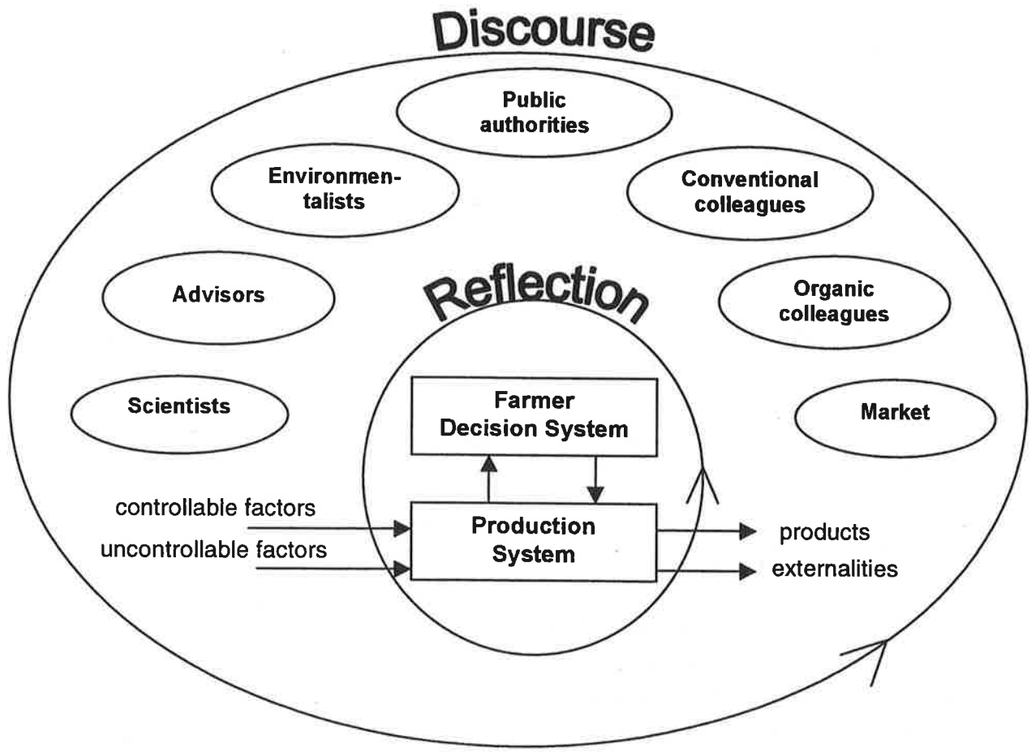

Figure 1. A model of the farmer reflecting on the farm's sustainability in light of the value systems and discourses in society.

As shown in the model (figure 1) a lot of groups are expected to influence the definitions of sustainability in agriculture. It must be realised that not all groups' perception of sustainable agriculture can be acknowledged since there will be conflicts between groups and some are more dominant than others. A major problem for the scientists as well for the farmers and advisors is to reduce the complexity and be able to forecast the coming dominant perception of sustainability. The next step is to reconsider the current farming activities in the light of this guess.

Changes in the general perception in society can be analysed by means of social science by the so called discourse concept (Michelsen, 1994). According to encyclopaedia the definition of a discourse is the opposite of intuition, i.e. a logical and coherent thinking involving a development of arguments step-by-step. A discourse is based on values and includes anonymous rules of thinking, definitions of what may be looked upon as problems of interest, distinct institutions and distinct types of practices. By using the discourse concept it is possible to analyse the process which constitute stability and change of society (Michelsen, 1994).

In relation to figure 1 the agricultural discourse expresses the current value systems including the interpretation and perception of sustainability. The farming community as well as the other groups in the society try to promote their values and perception of sustainability and challenge the dominant discourse. A competition for discursive hegemony is supposed to be going on (Michelsen, 1994).

Changes in society's perception of agricultural values have been a major reason for implementing systems theory in agricultural science in many cases (Bawden et al., 1984; Scholl & Holt, 1990; Thompson, 1997; 5 cases in Gibon et al., 1996). The argument has been the need of a tool to deal with the increased complexity due to these changes. The normative dimension of agricultural research is therefore acknowledged. However, only few scientists has described how to handle and reduce this complexity in a way which acknowledged the normative dimension. The discourse concept offer means to do this, but it must be realised that this concept is still very new and therefore relatively untested within agricultural science. However, the discourse concept is not crucial to the model shown in figure 1. The crucial point is to be aware of the complexity, the conflicting interests and thus the ethical questioning, and the need for forecasting the expected dominant perception of sustainable agriculture, and on this basis, to develop indicators of farming systems performance in the light of new issues.

Assuming that the agricultural discourse (the dominating perception of sustainable agriculture) has changed, the next step is to operationalize and reconsider relevant consequences of the current farming activities. Other important research tasks are the different farmers' possibilities and motivation for developing their farm in accordance with the new issues and with the type of information they need (indicator types etc.). Thus, both the active and the morphogenetic aspects of the management system are relevant for research in sustainable agriculture. The next section gives some examples of operationalizing environmental issues.

Thus the purpose of figure 1 is three fold:

- to show the potential of systems thinking for dealing with the farm's production and the related externalities in a coherent way,
- to show the need for a tool to describe the farm's sustainability in light of the changed discourse/new values and goals,
- to show the need for researchers to reflect carefully on which aspects of sustainability they should focus.

These aspects will be further described through examples in the next section.

Assessing sustainability in livestock farms - an example from Denmark

Change of agricultural discourse

A change of the agricultural discourse from values concerning economic productivity to environmental issues has occurred in Denmark from 1980 - 1992 (Michelsen, 1994). In 1987, the Danish Parliament set a goal of reducing pollution from Nitrogen (of which agriculture contribute 80%) and pesticides to 50% over 10 years. Thus, when sustainability became a buzz-word in the late 80's regarding agriculture it was in Denmark primarily linked with loss of nitrogen and use of pesticides, (MAF, 1991).

Along the increased focus on nitrogen loss and pesticide use organic agricultural systems have experienced an increased interest.

Before the early 1980's, organic agriculture in Denmark was limited to a few idealistic biodynamic farmers and their organisations. The number of organic farmers increased from 30-100 before 1980 to approx. 1500 in 1997 corresponding to 2% of the agricultural area. Since 1992, the Danish Parliament has considered increased organic food production as a means to reduce environmental problems. One of the latest political initiatives is the so called "Action Plan for Promotion of Organic Food Production in Denmark" by the Ministry of Agriculture and Fishery in 1995. In this plan it is expected that in the year 2000 the proportions of organic food will reach a market share of 15-20% and 7% of the Danish agricultural area (MAF, 1995).

Operationalizing environmental issues for livestock farms

As a consequence of the change in discourse the description of different farming systems solely in the terms of economic performance and production efficiency (for instance kg milk per cow or hkg grain per hectare) has become increasingly insufficient. Different groups of interest outside the agriculture have questioned for instance the nutrient balance and energy efficiency of intensive farming systems under the sustainability heading.

At the Danish Institute of Agricultural Sciences an interdisciplinary research project is aimed at developing indicators for resource use and environmental performance on livestock farms.

The idea was to develop a decision aid for farmers to facilitate the inclusion of these aspects together with animal welfare and social aspects concerning the farm family in the management processes (Sørensen & Sandøe, 1994). The indicators should therefore function as a feed-back of information from the production system to the management system in order to stimulate self reflection. They have thus, been chosen to fulfil certain requirements:

- they should describe and operationalize relevant aspects of farm resource use or environmental impact in a way suitable for use in multiple objective decision making,
- they can be calculated, measured or registered by farmers together with local advisors at a reasonable cost,
- farmers should be able to influence the indicator levels through management practice.

Not all aspects of environmental impact from farming are necessarily relevant for the farm's or even society's sustainability and some aspects are only problematic for society in a broad sense or for very future generations. Therefore, each indicator will be discussed with the farmers as part of an ethical learning process (see self reflection arrow in figure 1). The issues covered so far in this project and the parameters chosen to operationalize them are shown in table 1 and examples are shown in table 2.

Fossil energy is a limited resource and its combustion contributes to the atmospheric pollution. Both aspects make it particularly interesting for future generations to know how much energy is used for the current agricultural production. In terms of societal sustainability the question might be phrased: How dependent is our milk production on direct and indirect input of the limited reserve of fossil fuel? Therefore, the use of diesel and electricity for farm machinery and the energy used for production of farm input is calculated according to Halberg et al. (1994).

Nitrogen (N) lost from livestock farms contribute to ground water pollution and eutrophication of marine waters. Phosphor (P) might be lost to fresh water and is basically a limited non-renewable resource. Therefore, the surplus of N and P is of interest to both now-living and future persons and is calculated according to Halberg et al. (1995).

Other issues operationalized for use in an extended farm account are pesticide use and the room left for wild flora and fauna on the farm (table 1). These potential impacts on biodiversity and landscapes values have so far been described by the average number of standard pesticide dosages used, the percentages of weeds left in grain crops and the status and extent of small biotopes in percentage of the cropped area (Mayrhofer & Schwaberda, 1991).

Table 1. Indicators of resource use and environmental impact.

Topic	Reason	Indicators	Assumed relative importance for Living generations	Future generations
Area	LR	ha	high	low
Fossil energy use	LR, P	MJ total and per kg milk, meat, grain	low	high
Phosphorus balance	LR, P	P surplus, total, kg per ha, P efficiency	medium	high
Nitrogen loss	P	N surplus, total, kg per ha, N efficiency (N output/ N input)	high	low
Pesticides use	P	Avg. number std. treatments per ha (AST) % untreated area	medium	high
Biodiversity, Landscape	P, LT	% weeds in grain crops, % area with small biotopes, biological infrastructure	high	medium
Soil-structure	LT	Use of heavy machines	medium	high
Soil-fertility	LT	?, to be found	low	high
	P	Cu surplus, kg per ha	low	high

[1)] LR: Limited Resource, P: Pollution, LT: Long term destruction

The aim is also to include parameters describing potential long term effects on the soil. So far, only the risk of deep soil compaction have been operationalized. Soil fertility in a more biological sense will have to await greater consensus among soil scientists concerning the right measurements.

It should be noted that the indicators are based primarily on evaluations of farm management and production (for instance the flow of nutrients and pesticide use) whereas the actual effects on recipients like groundwater or atmosphere have been considered too expensive or insecure to measure. Soils and on-farm biodiversity might in this light be considered as something in between, since they are both part of the production system and affected by it.

Table 2. Examples of farm accounts, 1995-96.

Farm No.		1	2	3	min.-max.**
Total cropped area, ha		55	160	38	38-160
Milk delivered, t		577	906	0	306-906
Pigs delivered, t		0	0	102	102-384
Livestock units per ha		2.1	1.2	3.1	0.6-2.9
1000 MJ, total		2082	1887	5345	5345-9039
MJ per kg milk		3.3	2.3		2.1-4.0
MJ per kg pig				1109	844-1705
N-surplus, kg per ha		193	129	304	67-304
P-surplus, kg per ha		3	5	31	1-31
N-efficiency*	milk	26	23		15-34
	pork			41	28-47
P-efficiency	milk	83	57		19-83
	pork			38	27-68
Cu-surplus, kg per ha				0.2	0.2-1.0
Pesticides, AST		1.1	0.0	0.5	0.0-3.0
% untreated area		24	100	17	0-100
% weed in grain		0	18	2	0-22
% small biotopes		2.4	3.6	8.0	0-19

*) N-output (animalia)/N-input - N-output (vegetabilia)). **) 15 dairy and 4 pig farms.

Moreover, in agreement with Burkhardt (1989) and Thompson (1997) we do not claim that these indicators are sufficient to judge whether an agricultural system is sustainable or not. Indicators are meant as some researchers' suggestions for the operationalization of a farm's potential impact on someone's interests, now or in the future. As shown above these indicators have been chosen carefully in order to describe critical effects of the farm that have not traditionally been included in farm accounts (i.e. externalities). Many of these indicators describe effects on the surroundings that are not necessarily important for the sustainability of the farm itself (for instance N-surplus and loss) while others deal directly with effects on the farm's own production basis (i.e. soil structure). Thus, the indicators describe the current farming practices' impact on selected aspects of sustain-

ability at different levels (farm, region, country). But since they focus on the negative impacts on these sustainability issues they rather describe the non-sustainability. De Wit et al. (1995) have suggested a similar approach, i.e. defining criteria from explicit issues of unsustainability. They also stress the importance of using criteria suitable for multicriteria analysis but on a more aggregated level.

Referring to the previous section about interpretation of sustainable agriculture, indicators shown in table 1 build on the idea behind "resource sufficiency". However, because of the co-operation with private existing farms, the concept fully respects the idea behind "functional integrity" in terms of reproduction of crucial elements in the system (Thompson, 1997). The indicators are used as a part of an ethical learning process (see self reflection arrow in figure 1) (Jensen & Sørensen, 1997). The working together with farm families in the development of an ethical account, facilitates studies of the management system (functional aspects), its values and how it develops in relation to elements in figure 1 (morphogenetical aspects) (Halberg, 1996; Noe, 1997).

Creating knowledge about alternatives - environmentally friendly and productive livestock farms systems

As mentioned earlier, pollution with nitrogen and the high use of pesticides are considered major environmental problems in connection with Danish agriculture. The high use of pesticides is also connected to livestock farming, since crop production is considered as an important and integrated part of most Danish livestock farms. One way to look at these problems is to look at the trade-off between e.g. input of nitrogen and level of production. This can be done in a classic agricultural experiment. The problem, however, is that a livestock farm is very complex and there is a huge number of combinations of input factors. It is therefore very resource demanding and time consuming to create knowledge solely through experiments within existing agricultural systems.

A short cut to obtain reliable and acceptable knowledge about alternatives is to take the production process-view for the study of biological, technical and economical aspects in commercial farms. In Denmark this has been done from 1989-1993 in 20 conventional and 14 organic dairy production systems. The modelling of milk production (Kristensen & Kristensen, 1997), crop yields (Halberg & Kristensen, 1996), N-turnover (Halberg et al., 1995) and energy efficiency (Halberg et al., 1994) has given information of possible effects of extensification on these issues.

The above mentioned method is very suitable as long as there is sufficient knowledge about relevant alternatives within or close to the given agricultural systems. The problem, however, is that in some systems there are only few alternatives and therefore a lack of knowledge about more radical alternatives. In particular, there is a great lack of knowledge concerning livestock and cropping systems with no use of pesticides.

In organic farming, synthetic fertiliser and pesticides are not used. A crop rotation including perennial and N-fixing crops, together with the use of fertiliser of organic origin is regarded as the fundament for an environmentally friendly and productive farming system. Organic farming therefore offers another framework for obtaining knowledge and

making research than conventional farming systems do. This in combination with the increased general interest in organically produced food has resulted in a major research effort within organic production systems in Denmark for the purpose of producing knowledge about sustainable agricultural systems.

The latest initiative is the formation of a Research Centre for Research in Organic Farming including a new research station which started in 1996. The objective of this centre is to make research with a starting point in the organic concept and agricultural problems for the benefit of developing sustainable agriculture in Denmark. The purpose is to co-ordinate the organic research activities on the basis of the existing research groups in Denmark.

For some years, a growing collaboration between systems oriented researchers working with commercial farmers and discipline oriented scientists working with controlled experiments has inspired to seek greater co-ordination of research tasks. Thus, for example, nutrient turnover is studied on a number of private farms and more detailed registrations on selected farms and research stations. This type of collaboration stimulated the idea of an attempt to co-ordinate a whole new research programme where experiments on research stations and registrations on private farms are combined.

This idea has influenced two major research programmes which are conducted as the fundament for the Research Centre for Organic Farming. At the moment, approx. 100 scientists from 14 different institutes are participating in the centre (Kristensen, 1996a, 1996b). Figure 2 shows the headlines for the projects in the two programmes which are conducted from 1996-1999. It appears that the research programmes cover many different levels in the agricultural systems, for instance from the individual animal (I.5 and I.6) and properties of soil (I.3) to consequences for the society as a whole (I.8).

The basic idea has been to put together the research group so that all relevant disciplines and research methods were covered. The research effort has been co-ordinated with respect to the existing expertise and geography but in a way that leads to high stimulation and reflection in the different research groups. This is considered important in order to make more innovative research and to encourage that the scientists' interpretation of sustainable agriculture becomes as explicit as possible. Finally, introducing systems thinking as a core of the research programme draws the attention to the idea that researching in organic farming and sustainability issues is not only a question of getting more knowledge of the structural/ontological aspects which are normally in focus in reductionistic agricultural research. The research programme must include the functional and morphogenetic aspects of the production as well as the management system in order to give suitable and coherent information about the possible role of organic farming in relation to sustainability issues.

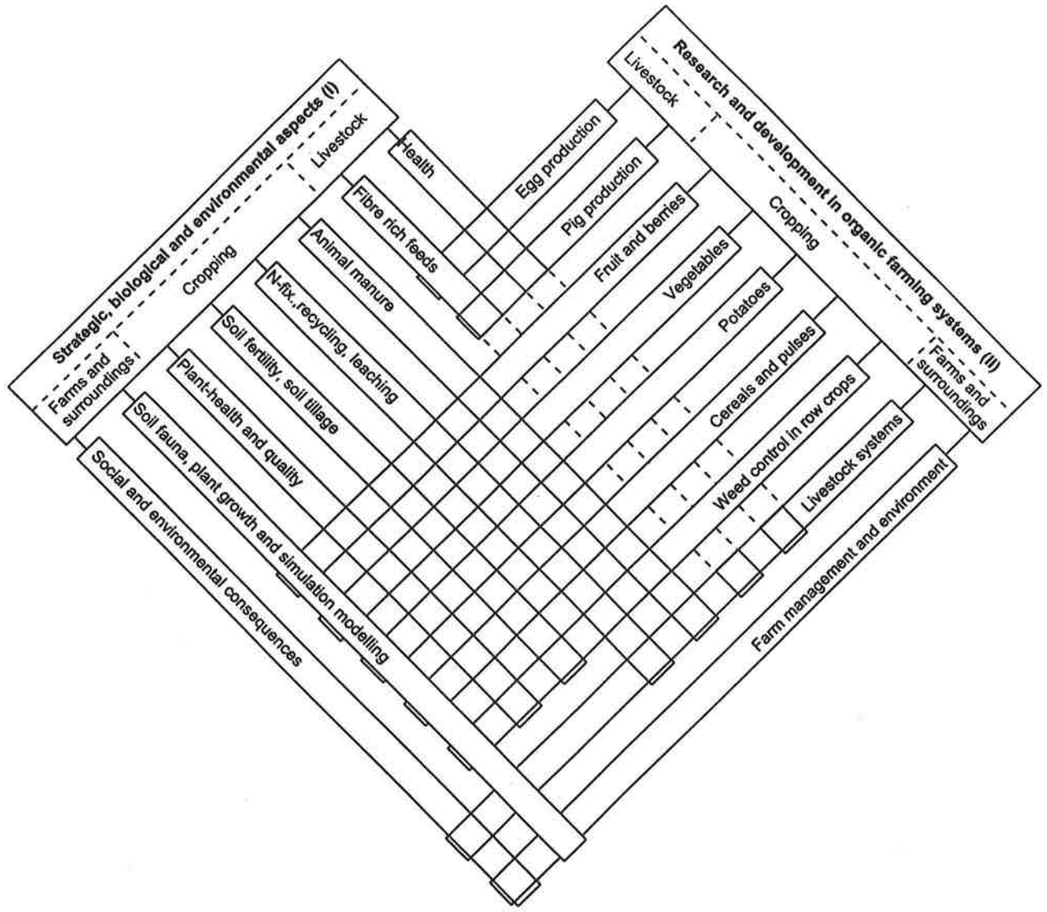

Figure 2. Research relationships within and between Programmes I and II (figures in brackets shows the individual projects. (Kristensen 1996a, 1996b).

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Diskusjon og oppsummering

Tverrfaglighet
Gårdsstudier er i sin natur tverrfaglige, noe de norske prosjektene har vært på ulike vis.
Metodikken blir en krysning mellom naturfag og samfunnsfag, og bør utvikles i dialog mellom de ulike fagområdene. Det er viktig å arbeide fram et fellesskap omkring oppgaven, da blir fellesskapet i metodikken mer sekundært.
Prosjektene hadde kanskje tjent på å hatt med samfunnsfaglig utdannede personer i større grad, men i praksis er det som regel agronomer som beveger seg mot samfunnsfaget og ikke omvendt. Senter for bygdeforskning har vært et hederlig unntak. Likevel er ikke samfunnsforskere med nå etter 8 års arbeid – det er liten interesse for slikt arbeid ser det ut til. Hittil har det vært vanskelig å meritere på tverrfaglige stillinger i universitetsmiljø.

Systemforskning
Det kan være viktig å skille mellom studier ***av*** og ***på*** gårder. Gårdsstudier er studier av system forskerne ikke styrer. I de fleste tilfeller vil systemanalyse være nødvendig for gårdsstudier, men det avhenger av hvordan en definerer systemanalyse.
Erik Steen Kristensen fra Danmark mente at en her i landet burde orientere seg bredere internasjonalt. Per i dag er det vanlig å skue til engelsk-talende miljøer, mens det foregår mye ellers også, f.eks i Frankrike.

Problemstillinger gårdsstudier kan brukes til
De gårdsstudiene som har vært gjennomført har uten tvil vært viktige for utviklinga av økologisk landbruk generelt i Norge slik situasjonen for driftsformen var i disse årene. Gårdsstudier er dessuten viktig som bakgrunn for omleggingsplanlegging på gardsnivå. Slike studier er også viktige for nettverksbygging mellom ulike aktører: bønder, rådgivere, forskere, omsetningsledd og forbrukere. Brukt på en slik måte kan prosjekter med en slik arbeidsform være en utviklingsmotor for økologisk landbruk generelt og enkeltproduksjoner spesielt, ikke minst ved at en samler nødvendig kunnskap for utvikling av et nytt fagområde. Gårdsstudier kan slik brukes til å sette sammen eksisterende kunnskap. Fra økonomers synspunkt er gårdsstudier viktig ved at det gir flere eksempler og mer tallmateriale.

Oppsummering
Ut fra innleggene og diskusjonen underveis kan en konkludere følgende:

Gårdsstudier som metode innen landbruksforskning, og ikke minst innen økologisk landbruk, er kommet for å bli. Per i dag er det imidlertid ikke aktuelt med like stor ressursinnsats som tidligere, men det er viktig å opprettholde den kompetansen som er bygd opp innen slik metodikk. Internasjonalt samarbeid og kunnskapsutveksling er viktig

Gårdsstudier er en metode blant flere, og intet mål i seg sjøl. Metoden er godt tilpasset helhetstankegangen i økologisk landbruk. En må velge metode etter de mål en setter seg i et prosjekt.

Gårdsstudier kan være godt egnet til spesielle utviklingsoppgaver innen økologisk landbruk, for eksempel utvikling av nye fagområder og nye produksjoner.

Hovedpublikasjoner og litteratur om gardsstudier som metode.

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For nærmere informasjon om gardsstudier viser vi til øvrig litteratur fra gardsstudieprosjektene innen økologisk landbruk og til sluttrapporter med fullstendige publikasjonslister