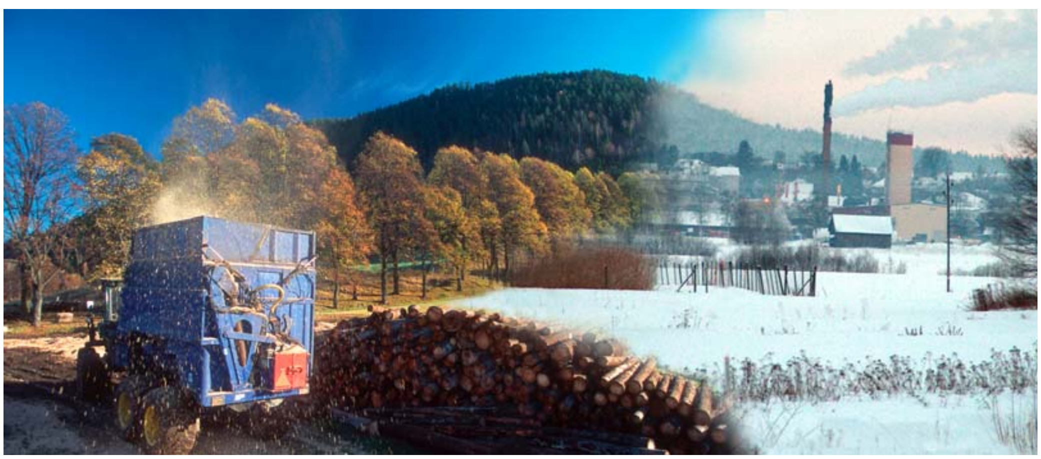
IEA Bioenergy

Task 31. Biomass Production for Energy from Sustainable Forestry

TECHNICAL PROGRAM NOTES

International Workshop

Sustainable Production Systems for Bioenergy: Forest Energy in Practice



Sweden and Norway

12-18 September 2004

and optional

Post-Workshop Study Tour in Norway

19-22 September 2004

Content

Sponsors, Organizers, Hosts

Technical program coordination:
IEA Bioenergy Task 31 Biomass Production for Energy from Sustainable Forestry
- Jim Richardson, Task Leader

Hosted by:
Växjö University, Sweden - Rolf Björheden, Sweden, Associate Task Leader
Norwegian Forest Research Institute – Simen Gjølsjø

Background

This is the fourth annual workshop held by IEA Bioenergy Task 31, which is concerned with 'Sustainable Production Systems for Bioenergy’. During the period 2004-06, the Task is collecting and synthesizing leading-edge science and technology on environmentally sustainable and economic production of bioenergy from conventional forestry systems, and using it to develop an integrative information framework. This information framework will be used to promote the use of sustainable production systems for bioenergy in an integrated way in relation to silviculture, forest management, harvesting and transportation.

Workshop Objectives

This workshop addresses the Task's aim to collect and synthesize leading-edge science and technology on sustainable production of biomass for energy from naturally regenerated forests and plantations that integrate forest management, environmental conditions and socio-economic factors. The objective of the workshop is to provide an opportunity and venue for resource managers, power industry representatives, bioenergy systems equipment manufacturers, energy production professionals, energy users, program managers, educators, scientists and researchers to exchange information and discuss sustainable management, production and use of forest biomass for energy as an integral part of resource management and community development. The workshop will focus particularly on implementing forest energy production systems.

Within that broad general topic, more specific consideration will be given in presented papers and posters and field study visits to practical questions of:

- effects of intensive forest energy use on site productivity
- efficiency and economics of operations
- social issues and community development
- infrastructure and logistics of forest energy operations
- identifying barriers to communication

Overview of the Workshop Format

The workshop format includes three days of technical sessions taking place in two different locations, Sweden and Norway. Technical sessions designed to achieve the workshop objectives will include presentations of invited papers along with volunteer papers. Field study tours will emphasize a wide spectrum of forestry and forest operations related to the focus of the Task, including silvicultural practices best suited for locally important forest types to meet demand for conventional forest products as well as emerging markets of bioenergy and biobased products, design and logistics of harvesting operations, and transport to wood products manufacturing and combustion facilities. Participants will also explore the richness of Scandinavian culture and traditions. This international workshop will offer attendees the opportunity to make and maintain professional contacts and to identify the opportunities for future collaboration.

Program Outline

Arrival in Sweden — **Sunday, 12 September**

Arrive at Arlanda International Airport, Stockholm, Sweden. Given flight details, you will be met at the airport and taken to Garpenberg's Conference Center, where there will be a reception and welcome buffet, as well as registration for the workshop.

Technical Session I & Field Study Tour — **Monday, 13 September**

A technical session will be held at the Conference Center from 08:00 to 12:30. After lunch (13:30) a field tour will follow on the theme of soil restoration and water management using forest by-products and growing energy. The day will end with a welcome dinner.

Field Study Tour & Excursion — **Tuesday, 14 September**

A field study tour (from 08:30 to 22.00) concerning "Energy provision in Hedemora municipality and rural district – forest energy in practice". The emphasis will be on small scale pellet production, local heating entrepreneurs, Hedemora municipality heating plant, local development and manufacture of heating equipment, harvesting of wood fuels, a small size heating center (a rural school). Dinner will be served during a boat trip on Lake Runn. The day will conclude with a visit to Falun –World Heritage Old Copper Mine.

Technical Session II — **Wednesday, 15 September**

The "Operations and Logistics" workshop will be held at Garpenberg's Conference Center, Sweden. Invited and volunteer papers will be presented on topics related to the workshop objectives, including regional presentations.

Arrival in Norway — **Thursday, 16 September**

After an early breakfast (06:00) participants will travel by bus to Norway. Large-scale forest fuel harvesting will be visited en route to Norway. After a visit to the forestry museum in Elverum (www.skogmus.no) participants will be taken for overnight accommodations to Sanner Hotel in Gran (www.sanner-hotell.no).

Technical Session III — **Fri, 17 & Sat, 18 September**

Industry Day at Sanner Hotel on Friday, 17 September.
A technical workshop session will be held on Saturday, 18 September. The lunch break will include a visit to the Energy farm (www.energigarden.no). At 16:00 after the conclusion of the technical sessions, participants will depart from Sanner Hotel to the Raukr Vikingcamp. Everybody will travel in Viking boats to an island in the Randsfjord and experience the old and exciting way the Vikings used to live 1000 years ago (www.raukr.no).

Optional Post-Workshop Tour **Sun, 19 – Tue, 21 September**

An optional post-workshop tour is being offered starting **Sunday, 19 September**.
It involves a trip from Gran (Sanner Hotel - departure time 09:00) to Voss (West-Norway) with one of the most popular tours: “Norway in a nutshell”. This famous tour will take you through some of the most beautiful scenery in Norway’s fjords. You can experience the breathtaking Flåm Railway line, the Aurlandsfjord, the Nærøyfjord (the narrowest part of the Sognefjord) and the steep Stalheimskleivane hairpin bends (www.fjord-tours.no/visartikkel.asp?art=94).

Monday, 20 September includes a visit to the Voss Bioenergi AS. After lunch at Fleischer’s Hotel everybody will travel by bus from Voss commune to Bergen. On the way from Voss to Bergen a visit to Vaksdal Biobrensel AS, (a factory that produces pellets and sells stoves) is being scheduled. Arrival in Bergen around 18:00 and overnight accommodations at Terminus Hotel AS.
Bjørn Hystad will be your contact person in Voss commune.

The Optional Post-Workshop Tour continues on **Tuesday, 21 September** with a visit to the Norwegian Forest Research Station in Fana, Bergen (hosted by research officer Dr. Bernt Håvard Øyen) and a study trip to an old spruce forest, planted in 1869. Lunch will be offered at Terminus Hotel, followed by a visit to Mount Floyen and the Funicular (www.bergen-guide.com/49.htm). After a coffee break at Bergen Forest and Tree Planting Society, the day will conclude with a city walk in downtown Bergen (dinner will be on your own and overnight accommodations - at Hotel Terminus in that city). The Optional Post-Workshop Tour ends in Bergen.

Technical Session Details

Workshop Technical Sessions	*Mon 13, Wed 15, Fri 17, Sat 18 September*

Monday 13 September

08:00 Welcome and Introduction – Rolf Björheden, Jim Richardson

Session 1. Effects of Intensive Forest Energy Use on Site Productivity
Moderator: Tat Smith

08:30 *Erik Ling, Sveaskog, Sweden* – Ash recycling makes Sveaskog's bioenergy sustainable

09:00 *D. Andrew Scott, Thomas Dean and Rick Stagg, USDA Forest Service and Louisiana State University, USA* – Energy trade-offs between intensive biomass utilization, site productivity loss, and ameliorative treatments in loblolly pine plantations

09:30 *Emily Carter, USDA Forest Service* – An evaluation of site impacts associated with alternative silvicultural prescriptions in an upland hardwood stand in northern Alabama, USA

10:00 Break

10:30 *A. Weatherall[1,2], A.D. Cameron[2], J. Craig[1], M.F. Proe[1] and A.J. Midwood[1], [1]Macaulay Institute and [2]Aberdeen University, UK* – The direct contribution of nitrogen from decomposing harvest residues to new tree growth

11:00 *Peter Salonius, Canadian Forest Service* – Silviculture for maintaining the resilience of Acadian mixedwoods: producing quality timber or biomass for unknown energy futures

Session 2. Social Issues and Community Development
Moderator: Semida Silveira

11:30 *Sarah Nilsson, Växjö Municipality, Sweden* – Large scale introduction of bioenergy in Växjö, Sweden - Moving from 80% oil 1979 to 80% bioenergy supply for heating 2002

12:00 *Boris Poff[1], Daniel G. Neary[1] and Michael R. Wagner[2], [1]USDA Forest Service & [2]Northern Arizona University, USA* – Applying traditional knowledge in Ghana for designing a fuel-efficient wood-burning stove using local materials

12:30 Lunch

13:30 Field tour (bus) incl. Coffee
'Soil restoration theme': Forest-fuel ash, garden residues and sewage sludge used to restore contaminated/degraded soils:

1. *Lilla Bredsjön restoration project*
2. *Treatment facilities and work at Brunna*

19:00 Welcome dinner at Garpenberg manor

Tuesday 14 September

08:30 Full day excursion (bus) – incl. Lunch, coffee breaks, dinner
'Forest energy in local practice theme': Visit to Hedemora municipality and its bio-fueled heating plant, lunch in Hedemora Stadshotell, courtesy of Hedemora town, solar cell heating in joint Hedemora/Säter municipality, cooperation with local sawmills, farmers'co-operatives for forest fuel.
Visit to Falun Copper mine
Dinner on Lake Runn

Wednesday 15 September

Session 3. Identifying Barriers to Communication
Moderator: Jim Richardson

08:30 *Semida Silveira[1] and Lars Andersson[2], [1]Swedish Energy Agency and [2]National Board of Forestry, Sweden* – Integrating forestry and energy activities in Lithuania using Swedish know-how

09:00 *John Raison, CSIRO, Australia* – Opportunities and impediments to the expansion of forest bioenergy in Australia

09:30 *C.T. Smith*[1], L. Biles[2], C.D. Foster[1], J. Gan[1], W.G. Hubbard[3], B.D. Jackson[4], and H.M. Rauscher[5]. [1]Texas A&M University, [2]Southern Forest Research Partnership, Inc., [3]Southern (USA) Region Forestry Extension, [4]University of Georgia, and [5]USDA Forest Service* – Knowledge products to inform rural communities about sustainable forestry for bioenergy and biobased products.

10:00 Break

Session 4. Forest Energy Operations: Efficiency, Economics, Infrastructure and Logistics
Moderator: Rolf Björheden

10:30 *Rolf Björheden[1] and M. Junginger[2], [1]Växjö University, Sweden and [2]Utrecht University, the Netherlands* – Experience and learning curves of primary forest fuel production systems in Sweden and Finland

11:00 *Pekka-Juhani Kuitto, Finnish Bioenergy Association (FINBIO*) – Bioenergy Trends in Finland

11:30 *Jan-Erik Liss, Dalarna University College, Sweden* – Alternative methods for forest energy harvesting

12:00 Lunch

13:00 *Jianbang Gan and C.T. Smith, Texas A&M University, USA* – Availability of logging residues and potential for electricity production and carbon displacement in the U.S.

13:30 *Jean-François Van Belle, CRA, Belgium* – Modeling energy balances and carbon dioxide budgets of lignocellulosic biofuels production and supply

14:00 *Toshio Nitami, University of Tokyo, Japan* – Regional Tactics for Forest Biomass Utilization at Mountainous area

14:30 Break

15:00 *Kalle Kärhä and Tomi Vartiamäki, Metsäteho Oy, Finland* – Productivity and costs of slash bundling and bundle forwarding

15:30 *Dominik Röser, METLA, Finland* – Simulation of combi machines in integrated timber and energy wood harvesting (presented by Antti Asikainen)

18:30 Dinner at Garpenberg manor

19:30 Task Business Meeting

Thursday 16 September

06:00 Breakfast

07:00 Depart for Norway (365 km, bus)
Visit to forest energy harvest operation and light lunch en route

14:30 Arrival in Elverum, Norsk skogbruksmuseum (Nor. Museum of Forestry)

17:00 Dinner at Norsk skogbruksmuseum

18:00 TBD - Forestry in Norway

Project leader Eiliv Sandberg. Overview of current status of bioenergy in Norway - and especially focus on the district of Hedmark

19:00 Departure Elverum

21:00 Arrival Sanner Hotel

Friday 17 September

<u>Industry Day</u>. Cost-Effective Systems for Production of Forest Fuels

Moderator: Olav Gislerud and Simen Gjølsjø

08:30	Welcome and Introduction – Simen Gjølsjø, Jim Richardson
09:00	*Erik Eid Hole, Energigården, Norway* - TBD
10:00	Break
10:30	*Petter H. Heyerdahl, NLH, Norway* – Bioenergy in the agriculture sector in Norway
11:00	*Lars Sørum, Sintef Energi, Norway* – Development of low-emission stoves in Norway
11:30	*Simen Gjølsjø, Skogforsk, Norway*
12:00	Lunch
13:30	*Niels Heding, Denmark* – Bioenergy development and status in Denmark
14:00	*Jim Richardson, IEA Bioenergy Task 31, Canada* – Sustainable production systems for bioenergy: IEA Bioenergy and Task 31
14:30	Break
15:00	*Rolf Björheden, Växjö University, Sweden* – Large-scale fuel production and future developments of forest biomass for energy
15:30	*Tat Smith, Texas A&M University, USA* – Environmental sustainability of bioenergy production systems
16:00	Discussion

Saturday 18 September

08:30	Discussion of Future Task Work Program – Electronic Information System, workshops, publications
10:00	Break
10:30	Task discussion continued
12:00	Lunch and visit to Energy farm
14:30	Task discussion concluded
16:00	Visit to Raukr Vikingcamp

Abstracts

Session 1. Effects of Intensive Forest Energy Use on Site Productivity

1.1 Erik Ling, Sveaskog, Sweden* – **Forest energy operations of Sveaskog – Sweden's largest forest owner**

Abstract

Sveaskog is one of the largest forest owners in the world, with its 4, 6 million ha of forest. On these lands Sveaskog has extracted bioenergy from 3000 ha of regeneration fellings and on 1000 ha of thinnings in 2003. This biofuel, which amounted to around 700 GWh was sold to industries and heating plants. The combustion of the forestfuels captured at Sveaskog resulted in approximately 6 – 9000 tonnes of wood ash dry matter.

To minimise the negative impacts of wood fuel extraction from forests, Sveaskog compensates for the loss of nutrients by recycling the ashes from bioenergy combustion. Since year 2000 the annual amount of ash spread in Sveaskogs forests has been around 3000 tonnes, but in 2003 this amount rose to about 5000 tonnes. The plan is to increase the amount of ashes for recycling.

Today Sveaskog has a leading role in ash recycling, and approximately 50 % of all ash recycled in 2003 was spread on Sveaskog's forestland. Sveaskog has identified ash recycling as a strategically important issue, both in terms of sustainability and in terms of an integrated business concept involving the whole process from the capture of biofuels in the forest to the recycling of nutritious substances to the forestland.

As a means to develop the ash recirculation Sveaskog is an active partner in the EU-Life project RecAsh. This is an ongoing parallell project in Sweden and Finland, in which methods and ways for ash recycling to forests are tested and evaluated. The aim is to show how ash recycling can be organised in an economicly and environmentally sound manner.

The talk will be about the integration of ash recycling into the forestry business as a whole and experiences from focusing on ash recycling as a vital part of a truly sustainable chain of bioenergy usage.

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1.2 Andrew Scott, Thomas Dean and Rick Stagg, USDA Forest Service and Louisiana State University, USA* – **Energy trade-offs between intensive biomass utilization, site productivity loss, and ameliorative treatments in loblolly pine plantations**

Abstract

Loblolly pine plantations are the single most important wood resource in the United States. Loblolly pine plantation management is getting ever more intensive in order to produce maximum yields. Harvest intensity is also becoming more intensive, as operations become more mechanized and markets develop for small-diameter wood for energy use. Increased harvest intensity, both in terms of biomass removed at harvest and the frequency of harvests, has the potential to reduce site productivity by reducing soil organic matter and associated nutrients. Two complimentary studies in the Gulf coastal plain of the southeastern United States were designed to test whether harvest intensity (level of biomass removed) will have a negative long-term impact on site productivity, and whether ameliorative treatments, such as intensive weed control and fertilization can restore or improve site productivity on soils common to the area. Removing crown branches, needles, and tops in addition to the merchantable bole has had a negative (10-30%) impact on pine biomass accumulation by age 5-10 years on 11 of 14 sites studied, but these productivity losses were ameliorated by intensive weed control and fertilization where applied. This paper will calculate the energy equivalents of the increased biomass harvested by the intensive removal treatments and compare these biomass increases with the energy equivalents of the productivity loss. It will also describe the energy required to ameliorate these sites and compare energy expenditures with energy gained through increased biomass.

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1.3 Emily Carter, USDA Forest Service* – **An evaluation of site impacts associated with alternative silvicultural prescriptions in an upland hardwood stand in northern Alabama, USA.**

Abstract

Even age management prescriptions (block clear cut) are commonly employed in upland hardwood stands of the southern Appalachian and mid-South areas of the southeastern United States to minimize recovery costs and encourage regeneration of low quality sites. Replacement of even-age management systems necessitates identification of prescriptions with less impact than clearcutting and promotes adequate regeneration. A study was initiated in 1996 to investigate site impacts associated with three management prescriptions: clear cut, strip cut, and deferment cut in an upland hardwood stand in northern Alabama. Pre harvest mean bulk density values ranged between 0.97 and 1.14 Mg m^{-3} while mean cone index measurements did not exceed 1.34 MPa. Soil disturbance patterns were relatively similar with approximately 20 % in an undisturbed condition, 55 % where evidence of trafficking occurred, and up to 20 % in rutted condition. Bulk density values of soil surface layers increased in response to harvest trafficking and were greatest in the clear cut site. Mean cone index values of the soil surface layer reached 1.5 MPa in clear cut sites which exceeded cone index estimates of other prescriptions evaluated. Mean cone index measurements increased with depth and were highest in the deferment cut followed by the clear cut.

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1.4 A. Weatherall[1,2], A.D. Cameron[2], J. Craig[1], M.F. Proe[1] and A.J. Midwood[1],*
[1]Macaulay Institute and [2]Aberdeen University, UK – **The direct contribution of nitrogen from decomposing harvest residues to new tree growth**

Abstract

The effects of the removal or retention of harvest residues (branches and needles) on subsequent stand establishment are difficult to quantify and appear to be highly site-specific. Factors responsible for observed differences in growth include the direct effect of residues on nutrient supply and indirect effects, such as changed microclimate and altered competition from ground vegetation. Measuring these effects is essential if the consequences of whole-tree harvesting on the long-term production potential of individual forests are to be understood. In this study, stable isotope enrichment techniques have been used to quantify the direct contribution from decomposing harvest residues to nitrogen uptake by restock trees on a clearfell site in Scotland.

In summer 2002, stem injection techniques were used to isotopically enrich 6-year-old Sitka spruce trees with ^{15}N. These labelled trees were harvested in autumn 2002 and used to replace residues in conventionally harvested plots on an adjacent clearfell site. New Sitka spruce seedlings were planted in the plots in spring 2003. Sample trees were harvested in July and September 2003 and a final tree harvest was taken in December 2003 at the end of the first full growing season after clearfelling. A direct N contribution from decomposing harvest residues to new tree growth was quantified in July and this contribution increased through the growing season.

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1.5 Peter Salonius, Canadian Forest Service* – **Silviculture for maintaining the resilience of Acadian mixedwoods: producing quality timber or biomass for unknown energy futures**

Abstract

Clearcut harvest prescriptions make survival difficult for regenerants of late sucessional Acadian species, which tend to be replaced by shorter-lived boreal species that can tolerate considerable exposure. Acadian temperate species are believed to have greater ability to adapt to and thrive in the environmental conditions that are expected as a result of climate warming during the next forest rotation.

A strip silviculture design is presented that maintains or improves the growing conditions for regenerants of late sucessional species. The design alternates operating strips and permanent leave strips. Permanent leave strips represent a minimum of 20% of the stand and contribute 'old-growth like' structure, with at least 10% of the dominant and codominant trees of each species as 'full cycle' / legacy / seed trees which are marked never to be cut. Less than 20% of the total stand canopy is removed at any one harvest entry. Harvest entries in neighbouring operating strips are at least 20 years apart with a return interval of at least 80 years. Partial harvesting may be done in the permanent leave strips from the operating strips at the time they are cut. Moist replacement air drawn from intact surrounding forest emulates the regeneration microclimate found in natural gaps, and the array of light conditions across the harvested strips accommodates the regeneration of the full suite of Acadian tree species. This silviculture is certifiable by any and all schemes in existence.

Variants of this strip silviculture are presented for two future energy scenarios:

1. If society continues to have access to cheap and abundant energy as it has during the past two centuries, then a continuation of the recent historical patterns of population growth and expanding economies will make silvicultural investments possible that result in the production of high quality saw log and veneer timber on rich sites. Only one example of the most intensive silvicultural variant that requires the highest investment before the harvest of mature trees, with six crown release and three pruning interventions, is analysed in detail. This variant is shown to be profitable under current cheap and abundant energy conditions that support export markets for specific high value forest products.

2. If export markets for specific high value forest products are forecast to collapse in a fossil energy scarce future and if energy demanding transportation to distant markets is not possible when currently regenerating forest stands are to be harvested, then investments in regenerating strips should not be considered given the likelihood that these stands will be more valued for the biomass energy they represent than for the quality of wood they can produce.

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Session 2. Social Issues and Community Development

2.1 Sarah Nilsson, Växjö Municipality, Sweden* - **Large scale introduction of bioenergy in Växjö, Sweden - Moving from 80% oil 1979 to 80% bioenergy supply for heating 2002**

Abstract

The city of Växjö has converted its energy system to biomass while maintaining good economy and obtaining additional benefits for its inhabitants. The municipal energy company started to use biomass in the district heating system in 1980 and the share have increased gradually since that at the same time as the grid has been extended. A 100 MW co-generation plant for biomass was built in 1996. Residue from forestry and forest industry within a radius of 100 km is used as fuel. The co-generation supplies 25-30% of the annual electricity consumption in the city. Small-scale district heating plants has been built in four villages outside the city centre, also fuelled by biomass. The ash is partly used as fertiliser in forestry.

There is not only a benefit for the environment:
New jobs have been created in the whole chain.
Domestic fuel makes the energy system is less vulnerable.
Users get comfortable heat for low price.
Companies in bio-energy sector have developed and formed a joint research and marketing company, Bio-energy Group Ltd.
The university has peak competence in bioenergy, research supported by companies in the Bio-energy group Ltd.
The sustainable energy system draws environmental tourism and technical visits to town.

Future projects include vehicle fuel through gasification of biomass and distributed cooling from district heating.

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2.2 Boris Poff[1], Daniel G. Neary[1] and Michael R. Wagner[2], [1]USDA Forest Service & [2]Northern Arizona University, USA – **Applying traditional knowledge in Ghana for designing a fuel-efficient wood-burning stove using local materials**

Abstract

Citizens of a developed country who use wood for a heating source are inundated with manufactures, retailers and all other sorts of information about fuel-efficient wood burning stoves. This information is only of limited value for two reasons. The first is that wood may not be available and the second is that the materials to make a stove may not be locally available. This paper presents a case study for Ghana in equatorial West Africa. It examines: (1) the potential of conventional forestry to provide wood fuel; and (2) how traditional knowledge can be used to build fuel efficient wood stoves or ovens that utilize locally available fuel, and can easily be constructed using locally available raw materials. This case study was conducted in Ghana, western Africa, where under current conditions, sustainable forestry appears to be an almost unattainable goal. This situation is due, in part, to the increasing needs of the general public for biomass fuels and also the country-wide trend of declining forest area. In Ghana, as well as most other developing countries, there are many types of improved mud, ceramic and metal stoves available that are fuel efficient. But these models, if not entirely made in a developed country, often need some metal part or ceramic assemblage that is not readily available or too expensive for the general public. We describe how adopting traditional oven construction techniques can be used to produce efficient wood burning stoves.

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Session 3. Identifying Barriers to Communication

3.1 Semida Silveira[1] and Lars Andersson[2], [1]Swedish Energy Agency and [2]National Board of Forestry, Sweden* – **Integrating forestry and energy activities in Lithuania using Swedish know-how**

Abstract

This paper is based on a bi-lateral project developed between the Swedish Forest Administration and Forest Department and the Ministry of Environment in Lithuania, with the support of the Swedish Energy Agency. The project has a starting point in the Lithuanian resource potential and institutional framework on the one hand, and the Swedish experiences with bioenergy systems, on the other hand. It looks at how the application of Swedish know-how in the form of mechanization and management practices can boost biofuel production in Lithuanian forests and help enhance bioenergy utilization in the country. A summary of the major issues assessed and evaluated are provided, indicating not only the complexity, but also the level of understanding and know-how accumulation that has been reached about biomass-based systems.

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3.2 John Raison, CSIRO, Australia* – **Opportunities and Impediments to the Expansion of Forest Bioenergy in Australia**

Abstract

There are significant opportunities for expansion of a forest bioenergy industry in Australia based on distributed electricity generation and production of liquid fuels (ethanol and bio-oil). If the large amounts of forest residues already available annually could be utilized, this would deliver useful greenhouse benefits, assist development of new forests and benefit silvicultural management. Creation of new forests for both environmental and commercial reasons will also provide residues in the future that could be used for energy production, thus enhancing overall viability of such projects. Currently, there are several serious impediments to realising the potential. These include:

- Uncertain greenhouse and renewable energy policy (specifically that relating to the Mandated Renewable Energy Target).
- Lack of proven efficient small-scale technology to enable distributed electricity generation, and thus reduced transportation costs for delivery of biofuels.
- Controversy over the sustainable use of native forest residues for renewable energy generation.
- Lack of markets for environmental credits (carbon, salinity, biodiversity).
- More efficient processes for producing ethanol including creation of commercial products from lignin, and adapting bio-oil to run diesel engines used for stationary power and transport.

In Australia, apart from the use of firewood for domestic heating, forest bioenergy has developed only to a very limited extent, despite the existence of major opportunities. A major impediment to expansion is lack of public acceptance and support, especially for the use of native forest residues which are the major available fuel source. A concerted effort at several levels is needed to address this issue.

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3.3 C.T. Smith[1], L. Biles[2], C.D. Foster[1], J. Gan[1], W.G. Hubbard[3], B.D. Jackson[4], and H.M. Rauscher[5]. [1]Texas A&M University, [2]Southern Forest Research Partnership, Inc., [3]Southern (USA) Region Forestry Extension, [4]University of Georgia, and [5]USDA Forest Service* – **Knowledge products to inform rural communities about sustainable forestry for bioenergy and biobased products.**

Abstract

Many rural communities in the southern USA still depend heavily on forestry. In fact, the South provides sixty percent of the nation's timber supply. However, southern rural communities are often economically and/or socially disadvantaged despite their rich endowment of forest resources. Recent setbacks in pulpwood markets create additional challenges to these communities and illustrate the importance and urgency of diversifying the utilization of the forest resources. Biomass development seems to be a timely and viable option, at least supplementing traditional income from sawtimber and pulpwood. A very high percentage of the nation's wood waste is available from timber harvesting and processing in the South, and therefore, the potential availability of bioenergy and bio-based products is very substantial.

We believe international research knowledge related to the development of forest bioenergy production systems based on conventional forest resources has great utility for the southern USA forestry sector. We must take advantage of what we already know to rapidly develop knowledge products to inform and train rural community leaders and practitioners involved in growing, harvesting, transporting, and processing biomass and bio-based products. Recent funding from the USDA "Biomass Research and Development Initiative" will enable the development of programs that will initially target those communities that show greatest potential for bioenergy and bio-based product development, including selected economically and socially disadvantaged rural communities in the South.

The objectives of this project are to: (1) Synthesize the available scientific and technical knowledge on improved systems for sustainably managing, harvesting, processing, and utilizing woody biomass in the southern United States; (2) Produce a wide variety of information and technology products from the tried-and-true such as curricula, fact sheets, bulletins, videos, etc. to the new and innovative such as a web-based hypertext encyclopedia of knowledge and web-based structured courses for distance learning; (3) Craft products into curricula, training events and programs; (4) Target marketing, outreach, and program delivery to southern forest managers and community development practitioners on improved systems for sustainably managing, harvesting, processing, and utilizing woody biomass. This campaign will include special emphasis on historically underserved segments of these communities; and (5) Provide program evaluation of the training curriculum products and events through peer reviews, beta-testing and end-user audience evaluation and feedback.

We will focus our efforts on providing the basic knowledge content for six major training modules: (1) An introduction to biomass use from forestlands in the South; (2) Silviculture treatments for enhanced biomass production; (3) Harvesting and processing biomass; (4) Utilizing biomass for bioenergy, biofuels and bio-based products; (5) Socio-economic impacts and community development issues; and (6) Developing environmentally sustainable biomass production systems for bioenergy and bio-based products.

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Session 4. Forest Energy Operations: Efficiency, Economics, Infrastructure and Logistics

4.1 Rolf Björheden[1] and M. Junginger[2], [1]Växjö University, Sweden and [2]Utrecht University, the Netherlands* – **Experience and learning curves of primary forest fuel production systems in Sweden and Finland**

Abstract

The concept of experience and learning curves is presented and its applicability on production systems for primary forest fuel (PFF) is investigated, using data from Sweden and Finland. Examples of learning curves and experience curves are described and discussed. Combined with bottom-up assessment of cost reduction opportunities, experience and learning curves may be used as forecasting tools, assessing future production cost development. Such tools are of interest both for Sweden and Finland who have already a significant and increasing use of PFF. They may also be useful in other countries, with less developed PFF fuel supply systems.
General findings are that, with the increasing use of Primary Forest Fuel (PFF), production costs have been declining at a steady rate for each doubling of accumulated production over the last three decades in Sweden and Finland with a progress ratio, PR, around 85 %. This implies that the experience curve concept is a valid hypothesis for forecasting future production costs. For the different steps in the forest fuel supply chain, sub-system learning and/or experience curves indicate that the PR depend on the complexity of work, of technological and organizational developments etc and may differ markedly from PR of the total sector.

Keywords: Logging residues, costs, biomass production, technological learning, forest fuel supply chains, experience curve

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4.2 Pekka-Juhani Kuitto, Finnish Bioenergy Association (FINBIO) – **Bioenergy Trends in Finland**

The full paper will be distributed to participants during the workhsop

4.3a Jan-Erik Liss, Dalarna University College, Sweden – **- "Undelimbed long tops" - A method for biomass production in final felling stands**

Abstract

In Sweden forest energy from final felling is traditionally harvested as logging residues after harvesting of timber (saw logs) and pulpwood. Depending on the market situation other methods with higher yield of forest energy might be of interest, for example harvesting of saw logs and fuel chips only, if the pulpwood price is low.

Dalarna University has in co-operation with GDE-Net done a pilot study on a method called "*Undelimbed long tops*" where only timber and chipped logging residues, included "normal" pulpwood, was harvested. The results have been compared with the traditional method for final felling. The study was done in three stands with some different conditions.

The surplus (forest owners net income) was higher in all three stands when the method with "undelimbed long tops" was used, compared to the traditional method for taking out forest energy, and the volume of chips was more than doubled. A reason for the higher income from long tops is that the costs for chipping is lower and the prize of chips is higher compared to chips from logging residues. Other reason is that forest owner's don't will be paid for wasted pulpwood, but will be fully paid for the chips from such pulpwood. Factors that will have a positive influence on the ULT-method are for ex large logging volumes and short distance between the logging area and the landing, different kinds of price reductions on pulpwood and large volumes of rotten wood or low paid industrial assortments.

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4.3b Tomas Gullberg, Dalarna University College, Sweden - **A small scale method for integrated haulage of logging residues and soil scarification**

Abstract

A new small-scale system with farm tractor and grapple loader trailer for integrated recovery of forest energy from logging residues and soil scarification using an attachment on grapple has been evaluated. The machine was in this case, when hauling the logging residues green, also used for hauling the round wood and may even be used for spreading wood ashes (only simulated). Conventional machine systems with special machines for all four types of work result in very high fixed costs for mowing etc. which makes cost unacceptable for many small objects.
The effective time per dry ton logging residues was 28,4 min in the integrated method, of which soil scarification was 14.3 min. Load size was about 1.3 ton dry matter.
Cost calculations show that the integration of several works result in substantially lower costs for small objects. For objects of about 2 hectare the cost is about the same as for conventional machines. The studied method creates new opportunities for self employed forest owners to make the work themselves and in case of lower personal cost and no mowing cost reduce cost further.

Keywords: harvesting residues, forest energy, forwarding, soil scarification, site preparation, farm tractor, ash recycling.

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4.4 Jianbang Gan and C.T. Smith, Texas A&M University, USA* – **Availability of logging residues and potential for electricity production and carbon displacement in the U.S.**

Abstract

This study assessed the regional distribution of logging residues and the regional potential for using logging residues in electricity generation in the U.S. The availability of logging residues was estimated based on the 1997 Forest Inventory Analysis (FIA) data. Because of the low bulk density and energy content of logging residues, it is not economically feasible to transport such materials over a long distance, unless transport costs are reduced by residue bundling, or other alternatives which increase mass per truckload. However, large amounts of biomass are required to fuel power plants that are economically competitive and technically efficient due to economies of scale. We derived the spatial distribution of logging residue biomass and associated minimum spatial density (Mg/ha) required for various sizes of power plants within an area defined by an assumed maximum biomass transport distance (100 km). The minimum biomass density was then used to estimate the amount of logging residue which could potentially be procured for electricity production in different regions. We assumed the use of an integrated harvesting system for harvesting and recovering both timber and logging residues. The amount of electricity generated from the logging residues and the electricity generation cost were estimated based on a gasification combined-cycle power generation system. Finally, according to the C emission rate from coal-fueled power generation and the cost difference between fossil- and biomass-fueled electricity production, the magnitude and cost of C displacement were derived.

There are about $2x10^7$ dry Mg of logging residues from forest growing stock (growing stock cut or knocked down during harvest but left on the ground) and additional $3.1x10^7$ dry Mg from other sources (wood other than growing stock cut or knocked down during harvest but left at harvest sites) each year in the U.S. Most residues are located in the eastern U.S., with over 50% in the Southeast and South Central regions. Assuming a maximum transport distance of 100 km and a 70% residue procurement rate, for most regions except the Southeast, South Central, Alaska, and California, the capacity of individual power plants should be smaller than 30 MW if only the residues from growing stock are used, and smaller than 75 MW if the residues from both growing stock and other sources can be procured. The residues from growing stock could generate $2.6x10^{13}$ kWh electricity annually; but the electricity generated would amount to $6.7x10^{13}$ kWh if the residues from both growing stock and other sources are used. This would displace $6.8x10^6$ to $1.74x10^7$ Mg C emitted from coal-fueled power plants, accounting for 1.2% to 3% of the total C emissions from the U.S. electricity sector in 1997. The cost of offsetting C emissions using logging residues in electricity generation would range from $40 to 50/Mg C, considerably lower than that of other C sequestration options currently available.

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4.5 Jean-François Van Belle, CRA, Belgium* – **Modeling energy balances and carbon dioxide budgets of lignocellulosic biofuels production and supply**

Abstract

Energy balances of biofuel supply chains are usually strongly positive. Different studies have been done mainly in the Nordic countries to estimate the gain of renewable energy from biofuel in comparison to the needs of fossil fuel to produce it. They have a ratio exceeding 5 and often 10. So far, these figures were sufficient to select a biofuel supply chain as they were used in a yes/no condition (positive or not).

The new market system of green certificates put in place in Belgium is modifying the way this ratio is used to select a supply chain. The CO2 emissions considered so far as an externality is now internalized through this system. It is now possible to quantify directly the economic influence of the CO2 balance on the viability or competitivity of a biofuel delivery chain.

This paper describes and analyses the main factors influencing energy balance and carbon dioxyde emissions of biofuel supply chains. A model allowing the calculation and prediction of energy and CO2 ratio is proposed. It is used to predict the green certificate benefit of a supply chain and eventually its new viability under the Kyoto Protocol.

Keywords: green certificate, biofuel, CO2, biomass, harvesting, logistic, energy balance.

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4.6 Toshio Nitami, University of Tokyo, Japan* - **Regional Tactics For Forest Biomass Utilization at Mountainous area**

Abstract

Narrow and dense roads are useful with Swing Yarder for harvesting forest biomass together with timbers at the mountainous terrain. Logs are harvested through hauling by an excavator mounted winch system, Swing Yarder, and processed by a processor. Timbers are forwarded by a small forwarder and residuals are compacted on the road to be forwarded. Roads for the operation would be 2.5m wide and 70m intervals on the slope. The logging productivity is 6 – 10 m^3 per man-day. Forest biomass will be converted to fuel-gas to produce electricity and heat at a regional energy station and also transported to some place to provide energy for industrial plants and for another regional energy stations.

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4.7 Kalle Kärhä and Tomi Vartiamäki, Metsäteho Oy, Finland* – **Productivity and costs of slash bundling and bundle forwarding**

Abstract

The number of slash bundlers and the volumes of slash bundling have been rapidly increasing in the last few years in Finland. The slash bundlers pick up tops and branches, place them into feed mechanism, and then compress, wrap and cut a 3 meter slash log about 70-75 cm in diameter. At present, there are nearly 30 slash bundlers in use in Finnish forests. In 2003, more than 0.7 million slash bundles were produced. However, neither wide time nor follow-up studies concerning slash bundling technology have been carried out in Finland.

Therefore, Metsäteho investigated the productivity and costs of bundling and bundle forwarding in different harvesting conditions. The research methods included both time and follow-up studies. Research data was collected during summer and winter period mostly from Norway spruce dominated final cutting sites. The various bundling techniques exhibited by different bundlers (Fiberpac 370, Timberjack 1490D, Pika RS 2000, Valmet WoodPac) were under study. The bundle forwarding study investigated also the effect of forwarder load space (comparison between the standard and larger load spaces) on forwarding productivity.

The results of bundling study pointed out that the productivity of bundling can be easily improved and further the costs of bundling can be decreased, e.g. the slash stacks should be of big size and good quality, the feeding tables of bundlers should be larger and the working methods of operators should be more productive. In addition, the results of bundle forwarding study indicated that the load space of forwarder should be larger. When using forwarder equipped with larger load space, over 20 bundles per load can be forwarded.

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4.8 Dominic Röser, METLA, Finland* – **Simulation of combi machines in integrated timber and energy wood harvesting**

Abstract

Integrated harvesting of industrial round wood and energy wood has been used to improve the efficiency of the recovery of forest energy. Particularly in young stands integrated harvesting enables higher total yields. In Finland, separate and integrated harvesting of timber and energy from young stand are altered depending on the stand conditions and the demand for pulpwood and energy chips.

Since the early 1990s interest in the combi-machine has increased gradually and today these machines are manufactured by all the major forest machine producers. Nevertheless, due to compromises to the harvester head and performance constraints, the benefits of the combi-machine are limited to certain stands and conditions. Until now, studies of the combi-machine have been restricted to system and productivity analysis on a stand level.

The innovative aspect of this study is to examine the parallel use of the harvester-forwarder chain and a combi-machine at the contractor level. By having both types of machines the contractor has the opportunity to benefit from the advantages of each machine, therefore increasing his or her options and flexibility. It is the objective of this study to examine how the contractor can attain the most benefit if a combi-machine is added to his fleet. In addition to roundwood the combi-machine also harvests energy wood in suitable stands. In young stands where the share of industrial wood is low, all trees are harvested for energy.

During the analysis a discrete-event simulation model will be used to investigate four different scenarios:

1) Baseline: All stands are harvested with Harvester – Forwarder system
2) Combi/Separate: Harvester – Forwarder is carrying out final cuts and second thinnings. Combi machine carries out all other operations
3) Combi/Balance: Combi machine is used to balance harvester and forwarder
4) Combi alone: all stands are harvested with a combi

During the simulation a typical series of stands will be harvested using the different scenarios. A GIS system will be used to determine location of the stands, resource availability and transport distances. The costs of the different scenarios and time consumption of the machinery are calculated and rules for optimal use of combi machines as a part of harvesting fleet in integrated energy and timber harvesting are described.

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Information for Presenters, Authors, Participants

Presenters

There will be 30 minutes allocated (20 minutes talk plus 10 questions/discussion) for each presentation. Slide and PowerPoint presentation equipment will be available for oral presentations. PC standard PowerPoint presentations are preferred. To ensure smooth presentation and avoid electronic hitches PowerPoint files must be delivered to Rolf Bjorheden on PC-formatted CD, 3.5" floppy discs or PC USB Memory Sticks at the latest the day before they are to be presented. Files may also be mailed directly to Ms. Ulla Haggkvist - ulla.haggkvist@garp-giab.se. PowerPoint presentations will be collected and made available after the workshop on the Task 31 website and/or on CD to all workshop participants.

Poster boards of size 1 x 2 meters will be available for your use. Printing and copying facilities will be available during the workshop.

Manuscripts

It is anticipated that the workshop proceedings will be published in Biomass and Bioenergy. Appropriate referees will review manuscripts. Full papers, written in English, from both oral and poster presentations, will be considered for inclusion in the proceedings. Slide decks will not be included. It is imperative that you follow the "Guide for Authors" as closely as possible in formatting your manuscript. From the home-page (www.elsevier.com/locate/biombioe) click on the Author Gateway (under Authors), and then "Guide for Authors," under the heading Submission Information.

Please submit a single hardcopy and an electronic version of final paper to Oana Popescu either: at the workshop (via Tat Smith); by post (Dept. of Forest Science, Texas A&M University, College Station, TX 77843-2135, USA); or email (opopescu@silva.tamu.edu). **Papers will be accepted until October 31, 2004.**

Guide for Authors

Adapted from Biomass and Bioenergy

Submission of Papers

Authors are requested to submit their original manuscript and figures with two copies to Oana Popescu either: at the workshop (via Tat Smith); by post (Dept. of Forest Science, Texas A&M University, College Station, TX 77843-2135, USA); or email (opopescu@silva.tamu.edu).

Submission of a paper implies that it has not been published previously, that it is not under consideration for publication elsewhere, and that if accepted it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the publisher. Papers should be written in English

Types of Contribution

These may take the form of research papers describing original studies (4000 to 6000 words), shorter technical notes and short communications (600 to 2000 words), state-of-the-art reviews, and topical reports. Society news and reviews of publications in this field are also accepted.

Manuscript Preparation

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Abstracts: An abstract (not exceeding 250 words) is required at the beginning of each paper (not technical notes and other notes). Abstracts should complete in themselves as possible. Conclusions should be summarized as well as the methods used, since abstracts are frequently quoted verbatim in abstracting journals. Abstracts should include not more than 10 key words which reflect the entries the author would like to see in an index.

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Mathematical Symbols and Formulae: Authors should attempt to visualize mathematical expressions as they will appear in print from the standpoints of readability and printing costs, formulae should be composed carefully and with the utmost economy. Some general rules are:

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b) Explain ambiguous or uncommon symbols by making marginal notes in pencil.

c) Double–line fractions should not be used in the body of the text. To indicate such fractions, use the solids (/), the negative exponent, or the division sign; thus, use a/b or ab^{l}, or b^{l}, or a÷b. Double–line fractions should be avoided also in centered equations if they can be expressed conveniently by any of the methods just noted and the resulting equation will appear on only one line.

d) The radical sign should be avoided. To indicate roots, use a fractional positive or negative exponent

e) Avoid double superscripts or subscripts as well as superscripts attached to the same symbol.

f) Indicate vectors by placing a wavy line under the symbol. Do not underline any other symbols or use underlining as part of a symbol.

g) When the number e is modified by a complicated exponent use the symbol exp.

h) Avoid use of the solidus (/) in descriptions of units — (e.g., use cm s^{-1}, not cm/s).

References: All publications cited in the text should be presented in a list of references following the text of the manuscript. In the text refer to references by a number in square brackets on the line (e.g. Since Raneses [l]), and the full reference should be given in a numerical list at the end of the paper.

References should be given in the following form:

1. Raneses A, Hanson K, Shapouri H. Economic impacts from shifting cropland use from food to fuel. Biomass Bioenergy 1998, 15(6): 417-422.

2. Thomsen A. Manual and automated TDR measurements. In: Petersen LW, Jacobsen OH, (Eds). Proceedings of the symposium: Time Domaine Reflectrometry. Application in soil science. SP-report No. 11. Danish Institute of Agricultural Sciences, Tjele, Denmark, 1995. p. 25-33.

3. Le Biossonnais Y, Singer MJ, Bradford JM. Assessment of soil erodibility: the relationship between soil properties, erosion processes and susceptibility to erosion. In: Wicherrek S, editor. Farm land erosion: in temperate plains and hills. Amsterdam: Elsevier Science, 1993. p. 87-96.

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Appendix: Mathematical analyses with details which are subordinate to the main theme of the paper should normally be put into an appendix.

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The technical sessions in Sweden will take place at Garpenberg's Conference Centre, which is associated with the College of Dalarna and has its roots in the former Royal College of Forestry of Sweden. Accommodation and meals will be provided on site. Garpenberg is about 2.5 hours' drive from Stockholm (1.5 hours from Uppsala), and 20 minutes' drive from the nearest railway station at Hedemora.

Garpenberg's Conference Centre:
Contact: Ulla Häggkvist
Phone: +46 225 26081
E-mail: ulla.haggkvist@garp-giab.se
Web: www.garb-giab.se/ginfo2e.htm

Train information for Sweden: http://www.resplus.se/default.asp?language=2
Train information for Norway: http://www.nsb.no/internet/en/index.jhtml?language=en

The technical sessions in Norway will take place at the Sanner Hotel in Gran, Hadeland. First established in 1930, Sanner Hotel was upgraded to offer conference and course facilities in 1970. Gran is about 50 minutes drive from Oslo, 45 minutes from the international airport at Gardermoen.

Sanner Hotell, Postbox 73, 2711-GRAN, Norway
Phone: +47 61 33 33 00
Fax: +47 61 33 33 01
E-mail: post@sanner-hotell.no
Web: www.sanner-hotell.no

Climate

In central Sweden in mid-September the average temperature is 10-12°C. Mornings may be cool but on sunny afternoons, temperatures can reach 20°C. Be prepared for the possibility of rain. On field study tours, stout footwear is advisable.

In Norway, the average temperature in September in the Gran, Hadeland area is 9ºC. However, in the middle of the day, the temperature could reach 20ºC. There might be some rain, the average precipitation for September being 80 mm. In the Bergen area the average temperature for September is about 12ºC and the precipitation is 260 mm. You should bring rain gear and some warm clothes.

More information about weather in Norway: http://met.no/english/index.html

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