Recent Reports on SRC Harvesters in Europe

Addendum to

Productivities and Costs of Short-Rotation Woody Crops Harvesting Technologies:
Projections for American Plantations

Final Report
to
Oak Ridge National Laboratory

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Table of Contents

by Raffaele Spinelli 8 March 2001

Report on the Segerslätt Empire 2000

by Raffaele Spinelli

21 January 2001

Introduction

The Segerslatt Empire 2000 SRF harvester is presently owned by the Institute of Agricultural and Environmental Engineering of the Agricultural University in Wageningen (IMAG-DLO), which has bought one year ago, after another year of rental use.

The machine is deployed at the Experimental Farm *Oostwaardhoeve,* located in the Wieringermeer Polder in the Province of North Holland.

The Experimental Farm Oostwaardhoeve

The Experimental farm has an extension of 250 ha, where new arable farming techniques are tested by IMAG-DLO. They work on wheat, potatoes, bulbs etc. - with a large emphasis on precision farming. The Experimental farm started working on SRF in 1994 and it has now app. 30 ha of experimental plantations.

They largely use local clones, but they also have a clone test with 20 different clones - many from abroad.

I visited the farm on Tuesday and Wednesday, January 16 and 17, 2001. I was hosted by Cor Sonneveld, the deputy manager, and had a meeting with the manager and with Dr. Hans Breteler - the general manager of the IMAG-DLO biomass project.

The farm is at the southern border of a comparably new Polder (app. 60 years old), of about 20,000 hectares. Polder size generally varies between 20,000 and 60,000 hectares.

Sludge disposal

Agricultural lands is very expensive over here - prices hovering around 100-120,000 Nlf (45-50,000 USD)/hectare. Revenues from agriculture are app. 10,000 Nfl/year for table potatoes, 15,000 Nfl/year for seed potatoes and much more for flower bulbs (but then land suitable for flower bulb production is even more expensive).

At present, SRF is not competitive with other crops, unless one integrates the revenues of biomass production with those coming from complementary services rendered by these plantations - namely phytoremediation. The Farm is experimenting the effects of sludge disposal and has already got a permit for application over 35 ha, which is going to be expanded to 100 ha soon. Within this framework, the farm is setting up a joint-venture with a local dredging firm for the disposal of dredging sludge on its SRF fields.

They have an intense experimental programme on the application of dredging sludge onto willow SRF plantations. Dredging sludge contains a certain amount of polihydrocarbonates (PHC), which are broken down into harmless compounds by bacteria in the willow root system. In order to prevent any risks of pollution, all the exhaust water from the SRF plantations is collected into a pond and sampled before being let out into the canal network. The risk is very limited - however - since any residual PHC would bind to the clay and would be quite hard to leak.

The sludge comes from canal dredging and is first separated mechanically into sand and clay. The sand does not bind to any chemicals, so it is quickly recycled to the construction business. It is the clay that is eventually spread onto the fields. It is used in two different forms: solid (app. 50 % d.m. content) and liquid (app. 25 % d.m. content). The former can be spread only before planting or between cuts, whereas the latter can be pumped in at any time. To apply sludge, they wall the fields around and fill the space between the walls with the sludge. This is experimentally applied at different layer thicknesses, which vary between 30 and 100 cm. Regular measurements allow to check how quickly the willows can break down the PHC and if there is any accumulation of harmful substances in the wood or in the outlet water.

Willow on sludge grows twice as fast as normal, partly because of the high N content of the sludge and partly because of the water contained in it.

The price paid to the farm for the disposal of a sludge truckload is app. 1000 Nlf (450 USD), so that sludge disposal can be a very good business.

They do not use pig slurry - although this is widely available. The reason is that pig slurry is more difficult to handle: it must be spread on the soil immediately after collection and always before planting.

Biomass use

At present they do not know where to send the biomass they produce. There is a 4 MW cogeneration plant in another Polder, but it does not accept easily the biomass coming from outside its own province. Therefore, the farm plans to acquire its own small plant, which would solve this problem and provide an ideal demonstration of the whole cycle.

In The Netherlands there are no main biomass sources - except for urban residue. If you want to use wood biomass you must either grow it or import it.

Mechanization of SRF

Dr. Gigler and Dr. Sonneveld worked a lot at finding the appropriate SRF machines for Holland. They made baling trials at the farm with a large square baler (New Holland type) on both

myscanthus and willow. Willow did not bale too well, so they tried a round baler - again with mixed results. They would like to bale - though - because they need to store their fuel.

Both Dr. Gigler and Dr. Sonneveld travelled widely through Scandinavia, to see both planting and harvesting machines. They wanted a stick-harvester because they needed to store the biomass and they could not store it as chips. Dutch climate is much wetter and not as cold as the Scandinavian one - so that chip would store very badly.

Except for the Segerslatt, none of the stick harvesters available are designed for industrial users. therefore, they decided to give the Segerslatt a try. The machine was rented during the previous harvesting season, when they had to cut most of their field due to some serious epidemic of black cancer. They harvested app. 15 ha and were so satisfied with the machine that they bought it from Mr. Sten Segerslatt.

Dr. Gigler was employed on a temporary contract, which expired one year ago. At present Dr. Gigler is in New Zealand. IMAG-DLO was very satisfied with Dr. Gigler's work and is actively looking for funds to hire him again.

The machine

The machine is based on an International Harvester combine, totally rebuilt by Mr. Steen Segerslatt. The Empire 2000 retains the original carrier, engine and cab of the IH combine.

The machine is mounted on a hydrostatic 4 WD carrier, with rear-axle steering.

Tab. 1 - *Specifications for the Segerslatt Empire 2000*

Engine	type	IH DT-436 7.15 liters
Power	hp	170
Transmission	type	4 WD - Hydrostatic
Weight	metric tons	app. 10
Width	cm	200
Max. harvesting speed	kmh	8
Max. travelling speed	kmh	30
Cutting device		2 circular saws, Ø 700 mm
Max. Ø capacity	mm	80
Max. tree height	m	9
Price	Euro	> 100,000

Notes: Data provided by the manufacturer

Price mentioned by Dr. Sonneveld. This is the min. price of the present specimen available at IMAG-DLO. If Mr. Segerslatt had to build a new one he would certainly ask for a higher price. I believe that our 170,000 USD estimate is correct

The tests

I carried out two tests on two adjacent fields. Both fields were planted according to the expanded Swedish system, with double rows spaced 75 cm between them and 150 from each other. Spacing along the row was 55 cm. This corresponds to a stand density of 16.000 stumps/hectare.

Field # 1 was 5 year old and had an estimated stocking of 35 odt/hectare. It had never been cut before, except for the standard back-cut at age 1. Field # 2 was 2 year old and had already been harvested once. It had an estimated stocking of 25 odt/hectare. Stools on Field # 2 had a rather expanse shape, whereas those on Field # 1 were more compact.

In total, we harvested 4 double rows on Field # 1 and 9 double rows on Field # 2.

I recorded cycle times with a stopwatch and field length with an Haglof hip-chain (double measures - go and return). Both fields were 270 m long, for a row length of 242 m. These fields are somewhat longer than standard fields, which here measure 250 m from canal to canal. Estimated stocking was obtained from Dr. Sonneveld. He stated that in some instances he measured field stockings as high as 40 odt/hectares.

In both cases, exit to the field was hindered by a row of stick piles lined along the edge facing the access road. Therefore, the machine would alternatively harvest according to the *One-way-return* and *One-way-reverse* methods (cf. Mitchell). That is to say, that the machine would drive forward until the far end of the field, turn and start harvesting. The bunk would be full halfway through the row, so that the driver would break out and drive by the side of the remaining row until he reached the field edge where the dump pile was. He would dump and then reverse to where he had interrupted the work in order to finish the row. At the end of the row he was at the field edge, so he had a shorter loaded drive. This whole procedure was repeated for each row. All rows were harvested as two equally long halves.

The break-out manoeuvre after cutting the first half-row was somewhat laborious. The operator had to stop the machine, reverse the conveyor run (in order to release the stems grabbed but not cut yet), back-up, start the conveyor to send to the bunk the stems still contained in it and eventually steer out of the row.

The driver was Dr. Sonneveld himself. The contract with the tractor driver had expired one year before, and since then Dr. Sonneveld doubled as driver. In fact, he had been there from the beginning together with the original tractor driver and had followed with this all the training sessions given by Steen Segerslatt. At the time of my visit Dr. Sonneveld had already harvested several hectares and showed total mastery of his machine.

Before starting the tests, the hour-meter indicated 1290 hours.

Recorded harvesting speeds were 8.2 and 8.7 km/h respectively for Field #1 and Field # 2. This is a net speed for harvesting only.

The turning manoeuvre took some time because the field edge was very close to the canal and the driver would not risk falling into it - of course. I stopwatched the machine twice while turning in an unrestricted space and I obtained 40 and 45 sec. respectively. I am now convinced that our 1 minute allowance for turning time is sound.

Piles at the field edge were eventually picked-up and moved around with a Caterpillar front-end loader.

Data are shown in full on a separate Excel file named: *Empire.xls*. This same file contains data recorded at the *Oostwaardhoeve* Experimental Farm in 1997 and kindly provided by Dr. Sonneveld himself.

Remarks on the machine

At IMAG-DLO they think that the Segerslatt is a very good machine, but that it could certainly be improved. Due to lack of funds they have made no modifications - however - except for the doubling of the hydraulic system that I will mention below.

Saws

Blade rpm must always be at the top, and the blades take a lot of oil from the system. This may interfere with the other functions, and therefore IMAG-DLO had the hydraulic system modified, by separating the saw circuit from the rest and installing a dedicated oil tank for it. With this arrangement they have solved all the problems with hydraulic power distribution.

They also bent down the saw supports, so that the saws would cut on a forward drop. This avoids that the disc surfaces rub against the cut stumps, generating a friction that would reduce rpm. The work was quite simple: they bent the supports using a tractor lift and then reinforced the stress points with appropriate welding.

Feeding conveyor

The conveyor has one speed only, which is synchronized to the top speed attained by the harvester when cutting. If the harvester works at a lower speed, then the conveyor will pull the trees towards the bunk before the saws have finish to cut them, closing the cut on the saws. This is not a great problem with small trees - which offer a limited surface to friction - but it can hinder operation with trees close to maximum capacity. Therefore, it seems that the Segerslatt is designed to work at one speed only, regardless of crop density!

Conveyor height can be adjusted to match stem height. It can be lowered in order to grab more safely small stems, but this will result in decreasing the loading height in the bunk - since the conveyor is lowered at both ends: forward and back.

Short stems can also slip between the conveyors and fall onto the bottom chute. If they are left there to accumulate, the mat of small stems will soon interfere with proper feeding. When harvesting under these conditions, regular chute cleaning is highly advisable.

Large trees (butt diameter over 10-15 cm) can cause the derailment of the upper conveyor chain. This chain is supported to its two ends only, and it does not have any "guide fins" (like chainsaw chains, for example) that keep it inside its rail. As a result, when two la rge trees are cut, the chain segment in between tends to slack down and it may eventually come off the rail. The day before my arrival, they tried to harvest a stand of large poplar trees (butt diam. 15-20 cm) but the machine did not work well and was strained too much. Eventually, they decided to cut the stand motor-manually and had a crew of three working through it while I was there.

Cutting height is also crucial to good feeding. Problems arise if the saws cut below the insertion point of the sprout on the stump. When this happens, sprouts from the same stump stick together and - although the conveyor tends to pull them apart - many are not separated from each other by the time they reach the bunk. Therefore, the first sprouts thrown towards the bunk cradle spring back towards the conveyor where the other sprouts are still momentarily held. this generates a reverse momentum that will eventually cause some sprout bunches to fall sideways or too close to the conveyor end. During the test in Field # 2, I observed two bunk jams caused this way (obs. 5 and 7). In both cases, it took app. 7 min to clear the bunk.

At any rate, the feeding conveyor worked remarkably well - which is not the case with many other SRF harvesters. This should be properly appreciated. If it his correctly operated and regularly checked, the feeding conveyor is unlikely to cause any important delays.

Prime mover

The machine is comparably heavy and requires adequate soil bearing capacity. It cannot work on unfrozen wet sites. Many of the Dutch farmers who have seen the machine have liked it, but they have expressed serious doubts on the capacity of the carrier to negotiate the Dutch fields. Some farmers are thinking to build their own version, which they would mount on a tracked carrier. One probably has already built such machine, which should be running somewhere. Dr. Sonneveld promised to check.

Dr. Breteler suggested to contact Mr. Johannes Falk in Denmark. He has just acquired a large contract for SRF willow harvesting in the UK and he plans to build a scaled-up version of his HE - All Rounder stick harvester, which might very well look like a tracked Segerslatt.

At the end of the trial the rear drive shaft broke and Dr. Sonneveld had to shut off the rear drive circuit to avoid that all the oil flow would go to the freely spinning shaft ("differential" effect). According to Dr. Sonneveld, shaft failure was caused by old age.

Bunk, bunk table and table conveyors

When the bunk is full, incoming new stems are kicked back by the butts of those already on the bunk (a bit similar to what happened with the MTDC feller-forwarder). therefore, the operator must be very careful not to overfill the bunk. To avoid this while maximizing load capacity, the operator has to lower down the bunk table during harvesting and regularly activate the table conveyor in order to spread the load wide over it and make room for new stems. This takes some concentration - however - as the operator needs to watch both the row in front of him and the bunk behind him at the same time. Besides, activating the table conveyor takes some hydraulic power from the system and makes steering somewhat more difficult. Associated with the distraction caused by bunk checking, this may cause slight losses of machine alignment, resulting in a few stems being missed - especially when stools have an expanse shape.

Bunk load capacity does not increase much when harvesting smaller stems, since they make up more or less the same bulk volume as larger stems. Indeed, although Field # 2 had smaller trees than Field # 1, the bunk would be full after harvesting more or less the same length of row as harvested in Field # 1. In fact, short stems tend to create a more disordered load that will fill up the bunk sooner. This happens because their limited length allows them to drop more casually into the bunk.

The bunk conveyors are another source of delays. The conveyors can be pinched and derailed by stems caught on the back run, if the table gets too close to the dump pile. We had one such occurrence during the 26 runs observed (26 half-rows) and it took 3 men app. 15 minutes to put the conveyor belt back in place.

Overall, the bunk arrangement presently mounted on the Segerslatt is a main cause of delays and one may think if it would not be better to replace it with a simpler tipping bunk, dropping the conveyor table altogether. The load carried per turn weighs app. 1.4-1.8 metric tons and could be supported by a lighter bunk. I doubt that bunk tipping would destabilize the machine, given the limited weight of the load and the possibility of using a lighter bunk frame.

All things considered, the Segerslatt machine is a very good piece of equipment with a potential for smooth and productive operation.

Report on the Claas 840-HS2

by Raffaele Spinelli
13 February 2001

Introduction

The new Claas SRC harvester was observed in operation during a visit to Agrobränsle (Agro-Energy) on February 8th and 9th, 2001.

Agrobränsle is affiliated to the Swedish Association of Farmers' Cooperatives – Läntmannen. Farmers' Cooperatives are active at a County level and the consolidation of a majority of the County Cooperatives has generated this large Nation-wide organization. A few County Cooperatives are still independent, but they represent a small minority.

The Läntmannen logo is a nicely-designed sprouting seed.

During my visit I was hosted by Gustav Melin, Agrobränsle's Chief Executive.

Agrobränsle owns and operates 6 Claas harvesters – all new 840 model units fitted with HS2 headers.

The new Claas SRC harvester - general

The new Claas SRC harvester is based on a new carrier – the 840 – which is more powerful and more compact than the old 695 Mega. Compact design should allow for faster turns even on narrow headlands.

The new header – the HS2 – is a complete new design. It is a purpose-built tool and not a modified sugar cane header. The circular saws have a larger diameter. The crop divider is still there, but the two vertical feed rollers have been replaced by crop-collectors with solid steel fingers. Two augers are mounted on the sides and before the saws, acting as crop gatherers. The new header looks more compact than the old one and offers better visibility to the driver. The machine was developed in Germany, but the Swedish users have added a few modifications, as suggested by practical experience.

On March 8th two trials were conducted on Earl Erik Loewehoed's estate. This member of the Swedish nobility is very much involved in SRC and has planted app. 150 ha of SRC willow. He is also a producer of willow cuttings, although his main business is lawn production for sport fields.

In its standard operating mode, the Claas harvester tows its own high-tipping trailer, which is dumped into containers placed at the field edges by a chip shuttle. The whole operation then consists of a Claas, a high-tipping trailer, a farm tractor and a container shuttle trailer - plus an appropriate number of containers.

The Claas has to extract and dump, but the extraction time is very short: rows are designed so that the trailer is full when the harvester is close to the row end, where a container has been placed. Unloading routine takes more time but, if the rows are short, the time spent for unloading is partially offset by avoiding the need to wait for the accompanying tractor to turn and position under the spout. Besides, the capacity of a Claas and two tractors exceeds that of the transportation fleet used at present, so that one would eventually run out of containers. On the other hand, if one used more trucks the chain would run into overproduction, generating more chip than the plant could use or store within such a short time. In short, the Claas harvesting system suffers from overcapacity when matched to the current users' needs. Furthermore, the present operation uses fewer machines and it is cheaper to move between harvest sites.

The machine was driven by Kolbjorn, who has operated Claas SRC harvesters since 1990, when he used the first towed Claas prototype.

Most of the questions concerned machine productivity and how a higher crop density would affect it. In particular, I tried to understand if a bigger stem size would hinder machine performance, and what would be a hypothetical threshold. This is particularly important if we want to adapt available data to the conditions offered by high-yielding crops in the US or in southern Europe.

The new harvester costs app. 2 million Swedish Kronors.

Productivity

Kolbjorn states that using the new harvester and following the above-described operating routine he will harvest 400 m^3 loose chip/ day as an average.

Last week he worked 11 12-hours shifts and totaled 8603 m^3 loose chip, including transport to field and all. That amounts to 65 m^3 loose chip/SMH – or 17 gt/SMH.

Last year, working from the beginning of November to the end of February they harvested 65,000 m^3 loose chip, but it was an exceptionally good year. Normally they harvest between 40,000 and 60,000 m^3 loose chip/year. According to Mr. Melin, Agrobränsle's target is 450 ha/year per machine, which is normally met working double shifts. This year – however – they will hardly meet this target figure, due to the unusually rainy weather. Harvesting did not begin until Christmas time. They are working triple-shifts but they will soon run out of time.

Kolbjorn estimates that the present Claas SRC harvester has app. 20 % more capacity than the earlier version based on the Jaguar 695. The reason for this improvement is in the increased engine power and in the better designed header. The new header is both smoother (fewer blockages) and more reliable (less downtime).

Mr. Melin states that the new Claas takes 2 to 2.5 hours to harvest 1 ha (moving excluded), depending on crop density. As an average, crop density in Swedish willow is ca. 35 gt/ha – which

is quite bad. That is a 2-hour job. On denser fields, machine productivity increases. However, top engine capacity is met at a crop density of app. 55 gt/ha. Beyond that, productivity declines.

Perhaps, one may put it this way. The Claas is a powerful forager with a nominal throughflow of 70 gt/hour. In SRC, it can approach this limit only when the crop approximates the characteristics of forage – i.e. when it consists of very many small stems. Here a record productivity of 50-60 gt/net hour has been observed in willow crops, when the rows were long and the harvester was assisted by an appropriate number of chip shuttles. However, in SRC a high crop density is frequently associated with a comparably large individual stem size, which in fact may slow down production if it exceeds a certain limit value – app. 50-55 mm butt diameter. Therefore, high crop density is not automatically associated with high harvester productivity and Mr. Melin stated that crop densities above 55 gt/ha may exceed maximum machine capacity, with a consequent decline in productivity.

Maximum shoot diameter

Maximum shoot diameter is a main concern when harvesting high-yield SRC.

Kolbjorn states that the new header will find its optimum value at 35 mm, with a maximum at 50-55 mm. He mentioned that on February 7th they tried to harvest a row of poplar shoots with a butt diameter of 60-70 mm, soon breaking some of the fingers on the crop collectors. He thinks that one can still make it, but one would need to beef-up the header.

Mr. Melin confirms Kolbjorn figures. He says that the header can occasionally handle even 75-80 mm diameter shoots, but that it will soon break if it gets a steady diet of these large stems.

Claas also produces more powerful foragers than the 840 model used by Agrobränsle – namely the 860 and 880 models. These could be fitted with a stronger header and could handle bigger material. The new header could use the same design as the HS2 but it should be bigger and stronger.

Maximum shoot height

Kolbjorn said that it would be problematic to harvest shoots taller than 7-8 m, as the machine might not be able to lay them horizontal for correct feeding. But he also said that one may always plant trees further apart along the row so as to leave more space for the cut tree to fall forward.

Mobility

The Claas harvester still has mobility problems. If the soil is soft the harvester will sink and the 4WD will not help much.

One can use wide tires when the spacing between double rows is extended to 150 cm, but wide tires have a low ply rating and are particularly vulnerable to punctures. In fact, both the harvester and the tractor observed on site used forestry tires to prevent puncturing. This is a serious problem in SRC, and it has not been solved yet with many of the agricultural trailers.

This winter some even thought to mount the harvester on a forwarder base, in order to deal with the soft fields – but that never went beyond the stage of proposition.

Chip size

Chip size is still very small, and Mr. Melin would like to produce bigger chips – even billets – to solve storage problems. The highest chopping distance is now 34 mm, and it is obtained by removing every other knife from the chopper drum. However, one cannot remove more knives, because otherwise the stems would hit the empty knife-mounts and break them.

Crop yield

The average stocking of Swedish willow plantations is 35-40 gt/ha at harvest. This is a poor result, caused by the lack of tending. If the farmer tended his plantation he would easily get 50 gt/ha after the third growing season.

A farmer in Skåne has obtained a record figure of 65 gt/ha after the third growing season, using the new Tora clone and tending it appropriately – i.e. weeding and fertilizing. Weeding is particularly important. Skåne is the southernmost region in Sweden, where they have longer growing seasons. This is the highest yield Mr. Melin has ever recorded in Sweden.

The same farmer set the record for the tallest 1-year-old shoot: 5.57 m.

Date: Wed, 14 Feb 2001 15:37:09 +0100
To: Bruce Hartsough <brhartsough@ucdavis.edu>
From: Raffaele Spinelli <spinelli@service2.area.fi.cnr.it>
Subject: New machines!

Hi Bruce!

More and more things are surfacing on SRC harvesters, as I deepen my investigations...I feel a bit like Philip Marlowe. In addition to the new Claas, we have a number of mysterious new machines, namely:

- Johannes Falk's new stick-harvester, now under construction. It promises to be another giant
- the Bender Mark V
- and now, the new harvester built by Mark Paulson (see following letter)

Raffaele

****

Rafaelle
Some while ago you emailed a colleague of mine Fred Walter with regard to harvesting technology. To keep you up to date where we are commercially with the project I have included an email sent out to interested growers in Europe in the past few days. If you know of or have nay harvesting work of your own on trial or commercial fields then please do not hesitate to give me a call.
The offer definitely stands to visit us at any time, and to see what SRC machinery we have been working on.
I hope to hear from you soon.
Regards
Mark Paulson
Coppice Resources.

Harvest email as follows:

When we were last in contact you expressed an interest in harvesting, and the possibility of CRL being able to come and harvest some SRC plantations for you. At the time we made you aware that we were in the middle of redeveloping our original harvester in order to better meet the needs of our customers.

We have now completed the modifications that we wished to make. These include a rise in horsepower from 180hp to over 400hp, a larger stronger cutting head has been built, and the chipping unit has been redesigned. This was aimed to put us in the position of being able to harvest larger diameter and taller SRC crops, and to be able to improve the quality of chipped material that is produced.

We have now successfully run the machine in our own SRC fields, and have found the results extremely pleasing. We are confident that we will be able to harvest SRC that has been grown for

four years without cutback, and also SRC that has missed a harvest year and is now consequentially much larger. The new header has also given us the flexibility to harvest crops that are planted on non-standard row spacing.

Chip quality is being improved, to the point where we believe we will be able to achieve a specification suitable for use in most gasification units. The end result of this is that we now have a harvester and skilled support team available for work. We have commitments in the UK and N.Ireland that will take us through to around the 25th of February. After this we will be moving to sites across Europe on a "first come, first served basis". If you still have some SRC to harvest and wish to be included in this years harvesting programme, then please contact me and I will book you into the system immediately.

Many thanks for your interest.

I look forward to hearing from you.

Regards
Mark Paulson
Coppice Resources Ltd.

Date: Mon, 19 Feb 2001 07:46:50 +0100
To: brhartsough@ucdavis.edu
From: Raffaele Spinelli <spinelli@service2.area.fi.cnr.it>
Subject: British Claas!

Dear Bruce!

I got this description of the new British coppice harvester, mounted on a Claas. I think they are a bit optimistic, but at any rate I am trying to organize a visit to them, too.

>From: "Mark Paulson" <Mpaulsoncrl@btinternet.com>
>To: "Raffaele Spinelli" <spinelli@service2.area.fi.cnr.it>
>Date: Sun, 18 Feb 2001 18:05:30 -0000
>Subject: Fwd: Re: SRC Harvesting
>
>Raffaele
>Thanks for the reply. We are currently sorting out all the details on output
>etc and getting action photos developed.
>In brief the new harvester is based on a Claas 860 forager - we thought we
>would go for the top in the power stakes!
>Productivity we estimate will be held back by availability of
>tractor/trailer haulage. With 2 to 3 tractors plus large 20 cube trailers
>running to a close store 15 minute round trip, we feel we can harvest around
>6 Ha per day, or somewhere around 300 wet tonnes.
>As for stool/trunk size we have not pushed into the larger crops yet. The
>old machine we had on 180hp has cut poplar at 4 inches (100mm) diameter and
>chipped it well, albeit at slower forward speeds. In theory we fully expect
>to be able to cope with 6 inch (150mm) thick poplar at good forward speeds
>and larger at slower forward speed.
>As we have more details and pictures I will forward them on.
>Regards
>MArk
>
>
>----- Original Message -----
>From: Raffaele Spinelli <spinelli@service2.area.fi.cnr.it>
>To: <mpaulsoncrl@btinternet.com>
>Sent: Thursday, February 15, 2001 4:08 PM
>Subject: SRC Harvesting
>
>
>> Hi Mark!
>>
>> Thank you very much for the message - I appreciate that!
>>

>> Although I am not planning to do any harvesting this year, your message
>> arrived at the very right time.
>>
>> I have been entrusted by an Italian customer to look for a machine for
>> harvesting for their SRC poplar. The harvest is not scheduled for this
>> year: they planted last year and are still planting now. But here the
>> growing season is long and our poplar clones are ferocious! Our customer
>> thinks he should harvest every second year - or even every year.
>Therefore,
>> we are planning for a first trial next season and we are looking for good
>> candidates.
>>
>> I am just back from Sweden, where I saw the new Claas 840. Three weeks ago
>> I was in Holland to see the Segerslatt stick-harvester. In fact, I did not
>> plan to come to the UK: I had ruled out Fred's machine because the old
>> model was on a farm tractor and our customers were looking for an
>> industrial harvester - not a farmers' machinery.
>>
>> But from your message I understand that the situation has changed: you are
>> talking about 400 hp! That is indeed something I am interested into...
>>
>> Could you please send more info? Description, estimated productivity
>etc...
>>
>> In Italy, our poplar would yield comparably large stems (definitely larger
>> than the swedish willow): what would be the maximum size that your machine
>> could handle?
>>
>> Looking forward to your reply...and possibly to meet you soon.
>>
>> Take care
>>
>> Raffaele

Report on the FVA trials with the Claas Jaguar 860

by Raffaele Spinelli and Carla Nati

22 February 2001

Introduction

The trials were organized by the Forest Research Institute of Baden-Württemberg (FVA) – Dept. of Ergonomics and Forest Utilization (AWF). The scientist in charge of the trials was Ing. Berndt Textor, a researcher at FVA/AWF.

Recently Baden-Württemberg has made a great effort to promote biomass-fuelled district heating plants. Over 100 such plants have been deployed in the last 5 years, for a total investment of 75 MW. Most plants are rather small, the largest being 2.5 MW in size.

Baden-Württemberg is very rich in forests and most of the fuel may be sourced there. At present, however, forest fuel cannot compete with sawmill residue, which is also abundant. The average price of forest chips is 16 DM/m3 vs. 10 DM/m3 for the sawmill residue.

In this context, Short Rotation Coppice (SRC) may configure as a complementary source of fuel, for compensating seasonal shortages of the other fuels. However, SRC proved unable to generate fuel at competitive prices and its surface has been rapidly shrinking in recent years. Sawmill residue is cheaper and forest chip more abundant, after all.

Nevertheless, much valuable experience has been obtained on this subject and the trials of last February are part of it.

The stand

The trials were conducted on a poplar SRC in Niedereschach, near Rottweil – 80 km East of Freiburg. The field measured app. 7 ha including headlands. It consisted of 73 single rows with average length of 380 m. Spacing between the single rows varied between 2.0 and 2.5 m – with an average value of 2.3 m. The field was planted in 1992 and was harvested for the first time in 1998 using motor-manual technology.

In Southern Germany – as well as in France and in Italy – poplars find better growing conditions than willows do. German clones were used for the plantation in Niedereschach: namely Max1, Max4 and Rochester. The growth rate was app. 5 odt/ha*year over the second rotation – half that much over the first one.

During the study, we measured a dominant butt diameter of 50-60 mm, with occasional maximum values at app. 80 mm. Dominant height was 7-7.5 m. As an average, there were 5 sprouts per stool. According to our measurements, field stocking averaged 32 gt/ha.

The crop was being terminated after the current harvest. A mulcher was driven twice over the stools to kill them off.

The machine

The machine was a Claas Jaguar 860 forager, equipped with a Claas SRC header of the first generation. The forager was 7 years old, and the header had approximately the same age. However, it had been purchased second-hand one year ago and the operator could not specify its exact age. The header looked rather battered: some welding scars testified to its having undergone some major repair on the lower pick-up roller mount. The operator said that in one year the header had given him no trouble.

The machine belonged to Aage Back, a Danish entrepreneur who manages a machinery center in Jutland, near Aalborg. The specimen observed had been hauled the previous day from Denmark, together with the operator, Mr.Christian. The haulier - Mr. Finn - sat with Mr. Christian in the forager cab, from where he would dismount every now and then to clear occasional header jams.

The forager was equipped with forestry tires to prevent puncturing. The operator complained that he was forced to use narrow tires because many of the Danish fields are rather old and they are planted according to the old 75/125 double spacing. Later on, interrow spacing was increased to 75/150 to allow using wide tires.

Mr.Christian declared that he would harvest app. 100 ha of willow every year, during the winter. The rest of the time, the forager would be equipped with its standard header and work in agriculture.

As an average, he would harvest app. 500 m3 of chip per day - working 8 to 10 hours. This amounts to a gross productivity of 15-18 gt/SMH, which matches our general predictions. Fuel consumption hovers above 300 lt/day - with maximum values of 350 lt/day.

The trial

The harvester took one row at a time, working on the "decreasing land" system. The machine discharged into a chip shuttle that traveled along it and on its left side. The chip shuttle consisted of a powerful Fendt 260 Vario farm tractor, towing a two-axle agricultural trailer designed to handle containers. The containers had an internal volume of 37 m3. Trailer and containers had been manufactured locally by MR – one of Rottweil's workshops. MR was represented by Mr. Rosenfelder, who assisted to the trial.

Since only one chip shuttle was available, the harvester had to pause every 3-4 rows and wait for the shuttle to change containers. For the rest, the work cycle was simple and regular. The harvest-run was comparably smooth, although the machine had to slow down quite frequently to "digest"

large stems. Short blockages would occasionally take place, with only one major event during the day of the trial. As an average, blockage amounted to 5 % of the harvest-run time.

The result of our data collection are in the attached excel file. Overall productivity averaged 19 gt/PMH. The harvest-run was conducted at an average speed of 3.5-3.7 kmh, resulting in an harvest-only productivity of 27 gt/PMH. The speed we have recorded matches Mr.Christian's readings of the speedometer - since he later declared that he was running at 3.5-4 kmh.

At 16:00 of the first day of the trial, after harvesting app. 3 ha, the forager suffered a major breakdown. The blower shed a paddle, which bounced around the blower casing and ended up in fragments into the chip container. The forager was taken to a garage in Rottweil for repairs. The spare paddle arrived from Claas early in the morning, but when testing the repaired blower it appeared that its axle had also been damaged and the machine was kept in the garage for the rest of the day.

Considerations

In 1995 we tried to harvest first-rotation SRC poplar at this same wide spacing and with the same type of header. The trials were carried in Diemelstadt (Niedersachsen) and they were unsuccessful. The poplar would not feed properly and the header would jam. We thought the problem was the excessive size of the trees and the wrong spacing, which caused the stems to hit the central crop divider. The success of this present trial has shed more light on what happened then. The first-rotation stand of 1995 offered single stems that were bigger and taller than the ones treated in 2001. At the time, the header had great difficulty laying the stems horizontal during the harvest routine, as the falling tops would hit against the tops of yet uncut trees on the same row. The butt of the cut stem would not go horizontal between the feeding rollers, but drop between the saw and the crop divider, thus blocking the header.

The butt diameter of the trees cut in 2001 was not much smaller than that of the trees cut in 1995, but their length was certainly shorter. We believe that the difficulties experienced in 1995 were caused by excessive height rather than excessive diameter.

This teaches one important lesson to the SRC grower: always do the cut back after the first growing season. Otherwise the trees will grow too tall for the harvester to handle. In order to reduce the cost of cutting-back one may use a tractor-driven disc saw, like the ISMA-SAF device.

The second lesson for the grower is: plant at the new 75/150 interrow spacing - or at any spacing that will leave app. 375 cm for the harvester to advance. Otherwise, any converted forager will need to use narrow tires, and it will be constrained by its limited floatation. Besides, machine size is constantly growing and a spacing wider than the old 75/125 might be prohibitive for an increasing number of harvesting machines.

The old header can handle a butt diameter up to 80 mm. However, at around this value, the saw cannot cut through the stem as fast as the machine is advancing: the stem gets broken and may feed poorly, causing a blockage. Mr. Christian declared he could not increase the saw speed any further, but it is important to check with Claas if this can be done by increasing the size of the saw motors or adjusting the hydraulics. Mr. Wiegelt has already been contacted.

The power of SRC harvesters is constantly growing. Harvest capacity is obviously related to available power, and this may prove a major disadvantage for the Austoft - the only viable alternative to the Claas so far. It will be important to check with Austoft if their 7700 model has several power unit options, and see what is the most powerful one. In case, if the capacity of the Austoft could be increased, would the conveyor keep up with the higher chip flow?

The Claas is definitely a very productive machine, but the breakdown observed in Niedereschach adds to a list of direct observations and users' complaints that conjure up the picture of a rather delicate machine. Mr. Christian declared that this was the first blower breakdown he had ever witnessed when harvesting SRC, and he also stated that the machine was generally reliable. However, it would be worthwhile to check with Mr. Back and Pieter Kofman to learn of their views on reliability.

Finally, the MR trailer/container system built by Mr.Rosenfelder is certainly interesting for the large capacity of the containers and the ability to close them with a lid. However, the system will need some improvements before becoming suitable to SRC.

First, the standard agricultural tires must be replaced with forestry tires or the vehicle cannot traffic SRC fields without incurring the risk of punctures. The mulcher made a first quick pass on the stumps just after the Claas cut them, just in order to clear dangerous stubs from the path that the trailer would follow when the harvester would take the next row. This would have been unnecessary had the trailer been equipped with forestry tires. Incidentally, it is not clear why the mulcher driver would proceed in reverse to clear the stumps. His tractor carried the mulcher on the rear-end - that is true - but he could have straddled the cut row and taken the stumps with the mulcher anyway, without needing to ride all day in a very uncomfortable position.

Second, the axles should be driven in order to increase cross-country mobility. At present, these trailers require a powerful 260 hp tractor to tow them through rough terrain. A much smaller tractor would be needed if the trailer was powered. Ideally, one may even use a 165 hp Fastrac to allow fast road travel, which is especially important if the tractor must also deliver the chips to the plant. That was the case in Niedereschach, where the tractor got a second driver and spent the night delivering containers to heating plants in a radius of app. 30 km.

Report on the Bender Mark III/2 and Bender Mark V

by Raffaele Spinelli

2 March 2001

Introduction

The two versions of the Bender were both designed and built by Salixmaskiner AB, but they were conceived at a distance of 5 years from each other and are radically different.

The Bender Mark III/2 is presently owned by Agrobränsle and is operated for it by Mr. Claes Johansson, who has hired a professional driver. This machine was studied under operational conditions on February 9th, 2001.

The Bender Mark V is under construction, following an order submitted to Salixmaskiner by SUNY. The machine was observed at Salixmaskiner's workshop in Hedemora on February 10th, 2001 already at an advance stage of construction.

Bender Mark III/2

This machine is the same studied by the UK Forestry Commission and by Prof. Danfors of JTI in 1995. The machine stayed idle for two harvesting seasons, pending a legal dispute between Salixmaskiner AB and the previous owners. It was then bought by Agrobränsle, who contracted operation to Mr. Johansson – owner of a handling and transportation firm.

The driver hired by Mr. Johansson has worked with the machine for 15 days before the study, but he is an experienced loader driver, has received thorough training and in general looked pretty confident on the machine.

Mr. Gustav Melin considers the Bender as a complement to the Claas for those small fields where it would not pay to move a big operation, and that is why he bought it. If you have a 2-3 ha field you should take there a Bender, not a Claas – he says. Otherwise moving time would make too high a percentage of the total harvesting time.

Mr. Melin believes in a "complementary" Bender, which may integrate the Claas system and replaced it on small-size fields. According to him, there is space for even smaller Bender versions. Lighter and cheaper units may afford working only 50-100 ha/year, and would become the ideal machinery for the small contractor and the large farmer. He suggests that further Bender development follow this direction rather the opposite one, as he sees competition with large foragers as a lost battle. The present trend towards Bender versions with increasingly higher capacities may not lead anywhere, as the machine will eventually cost as much as a forager without having the same productivity.

As far as Mr. Melin knows, this Bender is the only one that has ever worked on a commercial scale. He estimates that this machine has 40 % the capacity of a Claas.

The machine is still mounted on the same JCB 155-65 tractor used in 1995. In fact, this is a stand-alone harvesting system that can harvest, extract to a landing and even move on its own wheels between plantations: the JCB can travel on public road at a legal speed of 60 km/h – physically able to run at 80 km/h. For this reason, the machine is an ideal solution for small field harvesting. It has limited moving cost, it is self-sufficient and it is not as productive as to strain the supply chain downstream.

Estimated productivity is 25-30 min/bin – i.e. 18-25 m^3 loose chips/hour. That corresponds to 5 – 7 gt/hour. Lower productivity was recorded the day of the study because of the difficult terrain and the long extraction distance, which varied between 600 and 1000 m. Harvesting is carried out at a speed slightly lower than 2 km/h. The driver said that if he tried to go faster the chipper would choke and the engine die off – which was observed occasionally when he delayed slowing down the tractor as it encountered dense spots on the second field in Sodertalje. In fact, both my observations and the driver's statements seem to indicate that the Bender Mark III/2 has a lower capacity than the original Bender Mark III. This can be explained by the repositioning of the chipper. Since 1995 the machine underwent one major modification: the chipper was repositioned so that it would work at 90 ° to the incoming flow of stems and not at 45 ° as originally designed. This allows the production of a much better chip, without all the oversize pieces previously observed. Poor chip quality had already been detected as a major problem in the Elsamprojekt report, where Kofman and myself suggested a repositioning of the chipper. However, the repositioning as effected on the present machine may be too radical. Although it has worked in terms of chip quality, it has also resulted in a higher power consumption (estimated to an extra 30 %) that has depressed productivity. If we consider that the tractor has a nominal power of 155 hp and that less than 100 hp eventually reach the chipper, it is no wonder that the chipper will result underpowered, especially if it works at a 90° angle.

Chip quality has much improved, however. The chip is even, although a bit too small: app. 25 mm. The chip produced earlier contained too many oversize pieces – twigs and slivers that went through the disc only partially comminuted. Agrobränsle found that unacceptable and asked that solutions be found. One may wonder if a disc chipper is indeed the right comminuting device for SRC, which consists of very minute stems: these may be better treated with a drum chipper. In fact, the Bender was the only SRC cut-and-chip harvester using a disc chipper, and the new version has disposed of the disc altogether.

Another problem encountered during the study was the small twigs of undersize trees wrapped around the chipper feed rollers and eventually blocked them. When working in underdeveloped stands the operator MUST stop and clean the header after completing a load.

The crop gatherers worked very well even with the expanse stools met in Sodertalje.

A main plus of the Bender is its resilience to tire punctures, obtained by fitting Nokia Industrial tires on all wheels. These tires have a high ply rating and a shallow thread, for comfortable fast

road travel. However, they have very limited grip, as we saw when we fell into the pond and were unable to climb back ashore.

The shallow tire tread, the low harvesting speed and the use of a suspension system, all contributed to a very comfortable ride during harvesting: the best I have experienced so far.

The height-adjusting foot worked very well and did not sink, but of course the soil was frozen (or so we thought!).

In the past, an extra horizontal feed roller had been added just 50 cm above and 80 cm behind the front saw ride, on the inclined front ties. It was meant to help the shoot butts up, but it might have not worked properly as it had been removed years ago. The mounts are still there.

Bender Mark V

This is the machine being built for SUNY/Salix Consortium. It was observed in Salix Maskiner's workshop at an advanced stage of construction.

Compared to the earlier Bender versions, this is a completely new machine, lighter, more compact and with fewer moving parts. The working principle is also somewhat different. Of the old models it retains only the sawchain cutting device and the circular throat that affects the "hairpin" grab and the consequent bending.

The original disc chipper has been replaced by a 180 mm capacity auger chipper, mounted in a semi-open case. Compared to the disc chipper, the exposed auger device works on a wider surface. In fact, it has somewhat of a 3-D effect, whereas discs and drums only have a 2-D effect as they can solely work against an anvil or a ledger plate. The 3-D effect couples a higher work capacity with a more compact working tool. Chip size is varied either by changing the auger (Salix Maskiner offers 6 different types for this Bender model) or by mounting two feed rollers in front of the infeed and use them to adjust the flow of stems to the chipper. Otherwise, auger chippers are self-feeding.

The feeding chain and rollers of the earlier Bender versions have been replaced by two large toothed wheels. The wheels are moved by two independent variable displacement hydraulic motors, connected by chains to a large gear ring installed on the reverse internal side of each wheel. The two wheels still grip the stems adjustable between ca 50 and 150 cm from the ground and affect the characteristic "hairpin" bending. The space between the two wheels is such that they can feed stems up to a maximum diameter of 150 mm. This space can be adjusted manually.

The cutting device is a suspended sawchain as on earlier versions, but the frame has been widened to 220 cm to cover the full tractor width. The frame is fully suspended, connecting to the main frame through a floating linkage. Therefore, the cutting device can glide over the ground, following its contour. As it goes, the frame rests on the two front skids. Weight distribution on the skids can be altered by adjusting the linkage arms that connect the saw frame to the main frame of the header – just like on the three-point hitch of standard farm tractors.

The width of the cutting device was studied to match SUNY's tractor and to convert it into a non row-specific SRC harvester.

A cross-tie runs between the two lateral sides of the chainsaw frame, just below and in front of the chain back run, so as to protect it from stools that may catch into it and derail the chain.

The present header is approximately 100 cm shorter than the earlier versions and almost half as heavy. Weight is now in the range of 900-1000 kg, vs. the 1700-1800 kg of the Benders Mark III and IV. According to the Bender designer, for future machines, the weight could be further reduced by estimated 200-250 kg.

This header also requires less hydraulic power. It only uses 3 motors (saw and feed wheels), plus a fourth auxiliary motor to turn the discharge spout. These motors are fed through the tractor's own hydraulics and therefore the Bender Mark V comes without the auxiliary pump and oil tank.

The header is designed so that it can be quickly disassembled into its main components, for better service and easier transportation. Disassembling can be effected in app. 20 min, according to the manufacturer.

The cost of the Bender Mark V header is app. 1 million Swedish Kronor.

The machine will be ready to run in the second half of February. The agreement with SUNY is that the machine should harvest approximately 50 ha before being shipped to America, so that Salixmaskiner can work out any "teething problems". Harvesting should start at the beginning of March. The plan is to drive in the machine, harvesting SRC in Sweden, and possibly in France and Belgium wetter soil conditions too.

The manufacturer believes that the new Bender will effectively compete with the large foragers and furthermore believes in a future unit that can move between sites, harvest them and transport the chip – in fact, a self-contained harvest and logistic system rather than just a machine. According to Salix Maskiner's calculation this system, which is already under development, would be more profitable than any other of the existing direct chipping harvesting systems today.

Report on the Rodster Mark I and Mark II

by Raffaele Spinelli

8 March 2001

Introduction

The Rodster is another creation of Salixmaskiner AB and was originally conceived as a harvester for cuttings. However, the machine has been dimensioned in such a way that it can also harvest willow shoots for use as "ecological roadmarkers". These have a diameter of app. 35 mm and are obtained from standard SRC plantations. Therefore, the Rodster may qualify as a full-scale stick harvester

The machine consists in a bogie trailer with a deck to collect the cut shoots. These are sent to the deck by a double upwards sloping chain conveyor. Shoots are cut by the same sawchain-based cutting device equipping the Bender and Bundler harvester series. It can cut standard double rows and non-row specifically grown crops.

During my visit I could observe the two versions of this interesting machine.

Rodster Mark I

The machine was observed under operation on February 8th, 2001 at the Vallnas farm near Stora Mellösa, where it was harvesting cuttings on one of Earl Erik Loewehoed's nurseries.

The machine was attached to a 140 hp Valmet farm tractor. That is the engine power one normally needs for harvesting roadmarkers: their 35 mm diameter is in fact the largest size the Rodster Mark I can handle.
The unit observed at Vallnas was owned and operated by Agrobränsle. It was bought for app. 40,000 €, but Agrobränsle had to invest a further 5,000 € to modify it. The chassis is that of a forestry bogie trailer, fitted with an hydraulic offset beam. This way the Rodster can harvest on either side of the tractor depending on the working mode.

The cutting device is the same as for the Bender, built on the suspended sawchain principle.

The deck has two lateral gates, so that the load can be dumped from either side as expedient: the operator just has to open the appropriate gate and select the turning direction of the conveyor.

The machine has its own hydraulic pump and oil tank, powered by the tractor's PTO.

The operator declared that this unit will harvest roadmarkers at a rate of app. 4 hours/ha, including extraction to the field edge.

Jamming was observed when the saw cut below the insertion point of the shoots on the stump. When this happens, the shoots from the same stump stick together and - although the conveyor

tends to pull them apart - many are not separated from each other by the time they reach the deck. Therefore, the first shoots thrown towards the deck spring back towards the conveyor where the other shoots are still momentarily held. This generates a reverse momentum that will eventually cause some shoots to fall sideways, or too close to the conveyor end. This is exactly the same occurrence observed earlier with the Empire harvester.

Besides, short stems tend to bounce back towards the conveyor exit, making it difficult for the new incoming stems to reach the deck. This will eventually cause a conveyor jam (cfr. MTDC) The manufacturer claims to have solved these problems with new design on the Rodster Mark II model described below.

Rodster Mark II

This machine was observed parked in Hedemora, where it is operated by Salix Maskiner AB.

The Rodster Mark II is in fact a conversion of the old Bundler, obtained by removing the bundling device from the trailer deck.

This machine looks very much like the Rodster Mark I and works in the same way. However, it is bigger and somewhat simpler.

It uses one conveyor only, instead of two. The shoots are laid horizontal by a trip step placed a below and in front of the deck – under the conveyor itself.

The clearance between the two conveyor chains can be adjusted manually, by acting on the telescopic boom that connects them. This way, one can match conveyor clearance to shoot diameter and work with a broader range of stem sizes. In principle, the machine can handle fairly large stems. The manufacturer declared that the Rodster Mark II can easily harvest 80 mm diameter shoots and that in Finland they even handled 100 mm diameter shoots. The machine can be even suitable for the harvesting of young poplar in nurseries for its re-planting to long rotation forestry. Also according to the manufacturer the machine adjustable to a maximum diameter up to 150 mm, but harvesting stems of this diameter has not yet been tested.

The trailer is bigger and the deck is wider. The left side of the deck table can fold vertical and if one activates the deck conveyor chains while in this configuration, the machine will “roll” incoming stems and form a tightly packed load.

Once the deck is full, one can dump the load in the field or extract to an appropriate collection site. During extraction, the conveyor assembly is raised over the trailer beam, which is then straightened up for fast travel.

A basic Rodster Mark II will cost app. 60,000 €, which may grow to 80,000 € with the full optional package