Potash Production in Northern Sweden: History and Ecological Effects of a Pre-industrial Forest Exploitation

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SUMMARY

Potash (potassium carbonate; K_2CO_3) was one of the most important industrial chemicals in Europe prior to the 20th century. It was obtained from wood-ash from broadleaved trees, which was refined in several steps into the pure chemical. The production primarily took place in the periphery of Europe, in Russia and in the United states. In Sweden, potash was produced in the southern parts on a larger scale from the 17th century. In northern Sweden the production started in the early 19th century, reached considerable proportions within a few decades, and then ceased completely in the 1860s. The trees used were primarily birches (*Betula pubescens* and *B. pendula*). Previous research on the subject of Swedish potash production has concluded that the production ceased due to shortage of raw material.

Through studies of historical records and experimental potash production we challenge these conclusions. In our opinion potash production in northern Sweden lost out to German producers who started to produce potash industrially at the same time that production in northern Sweden ceased. The ecological significance of the potash production is difficult to estimate, primarily because the impact caused by this form of forest exploitation is obscured by subsequent logging and other human activities. Nevertheless, the removal of large old broadleaved trees was one important step in the large-scale transformation of the forest landscape which has influenced the structure and function of north Swedish forest ecosystems.

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INTRODUCTION

Agricultural utilisation, pre-industrial and industrial exploitation have replaced each other over time as the dominant form of human impact on the boreal Swedish forest. However, large-scale impact on the forest ecosystems did not occur until the 19th century, when logging became a major form of exploitation.[1] Before that time, human impact was more diffuse and is consequently more difficult to estimate and interpret today in a historical perspective. One type of pre-industrial forest exploitation, which locally reached substantial importance, was the production of potash. This chemical (primarily potassium carbonate; K_2CO_3) was produced by burning wood into ashes and then refining the raw wood-ash in several steps into potash. It was one of the principal chemical compounds prior to the 20th century and essential for the production of glass and soap. It was also widely used by the textile industry for bleaching and dyeing fabrics.

The industrial revolution created an increasingly strong demand for potash in the 18th and 19th centuries. As with the production of sawn wood at this time, the major growth in potash production was at the periphery of Europe and in the north American colonies.[2] In these parts of the world the raw material (i.e. different hardwoods) was abundant, and not a limiting factor for the production. Potash, unlike many other forest products, was also highly refined at the production site and was therefore relatively easy to transport long distances.

Previous research on the pre-industrial potash production in Sweden has concluded that the production peaked in different parts of the country at different times.[3] It has also been suggested that the production of potash declined primarily due to shortage of raw material.[4] External factors which influenced Swedish potash production, such as international trade and new methods of production, have only been investigated briefly. The actual supply of raw material, i.e. the state of the forest at the time, has not been analysed thoroughly either.

Aim of the study

The aim of the study is to investigate the production of potash in 19th century northern Sweden from an historical-ecological point of view, with particular emphasis on the scale of potash production in northern Sweden and on the resulting impact on the forest ecosystem. We also discuss previous assumptions concerning the rise and decline of potash production in northern Sweden. Our hypothesis is that external factors, and not shortage of raw material, provide the key to explain the relatively short duration of potash production in northern Sweden. We have used historical records and also conducted a field experiment to produce potash from birch-wood.

POTASH PRODUCTION IN SWEDEN

Southern Sweden

Potash has been produced in Sweden since at least the 13th century.[5] The historical source material from this time and in the centuries thereafter is scarce and does not give much specific information about potash production and potash exports from Sweden. In the 17th and 18th centuries, potash production is better documented. Various records confirm that potash was produced on a relatively large scale in the southern counties of Sweden in the 17th century.[6] In the mid-18th century, Linneaus described potash production in the county of Skåne in some detail. He pointed out that the raw material was mostly beech (*Fagus sylvatica* L.) and preferably dead or dying trees. He also described an elaborate method for refining the wood-ash by smearing it on pieces of wood and then burning it a second time.[7]

At this time mercantilism pervaded the Swedish economy, and there were strict rules regulating every step in the potash production. The trees which were to be used had to be marked out by government officials and there were detailed regulations concerning the production and the selling of the potash. The primary aim of the government at this time, in true mercantile spirit, was to avoid imports of potash for domestic industry. Although the production of potash in Sweden grew during the 17th century, it was primarily confined to the southern counties. According to available sources more emphasis seemed to be put on regulating production than on actually producing potash.[8] There are no compiled records of produced quantities or calculations of the impact on the forest ecosystems, but Åhman (1983) speculates that the production radically changed the forest landscape in southern Sweden at this time.[9]

Northern Sweden

In the late 18th and early 19th centuries a new upturn in potash production occurred, but now in the northern part of the country (figure 1). At this time the government tried to promote potash production by various measures, among which were the education of farmers and money-rewards to producers. An underlying thought was that farmers in northern Sweden needed subsidiary occupations in order to subsist.[10] The climate in this part of the country was harsh and the natural conditions did not really promote traditional agriculture. Potash production was therefore one potential source of income for the farmers. The resource which was used was seemingly endless and not used for any other reason. The production could also to some extent be contra-cyclic to the agricultural economy, and thus stabilise farmers' incomes. Other important forest based subsidiary occupations besides potash production, were tar production and logging, which successively replaced each other.[11] Potash was therefore

FIGURE 1. Potash production areas in Sweden in the 19th century (based on Strotz and Haggarsson 1994).

produced locally by farmers and then sold, or traded for other goods, to merchants in the towns. There are no records which indicate that potash was produced on a larger industrial scale in northern Sweden. Potash was primarily produced from broadleaved trees. In northern Sweden the two birch species (*Betula pendula* and *Betula pubescens*) and aspen (*Populus tremula*) were most commonly used. The coniferous Norway spruce (*Picea abies*) was also used in some cases.

The geographical distribution of potash production has not been investigated in detail. It seems however that production was concentrated in the two most northern counties, Västerbotten and Norrbotten.[12] From an extensive study by Tirén we have considerable knowledge about potash production in the county of Västerbotten. According to his findings one important incentive for making potash was the establishment of a glassworks near the town of Umeå in the late 18th century. Another important factor was the establishment of Agricultural Society of Västerbotten in the early 19th century.[13] The primary aim of the society was to promote traditional agriculture by introducing new breeds of domestic animals, new crops and new methods. The society also put considerable effort into promoting subsidiary occupations such as potash and salpetre production. The method applied for this was a combination of teaching and promotion by grants to the successful producers. The potash campaign in the county of Västerbotten was intensive but brief. The export of potash started in the 1820s, rose to 382,000 kg per year in the 1840s and then dwindled to zero again in the late 1850s (figure 2).[14] Some of the potash was exported to other parts of the country but most of it was sold abroad. It is likely there was also some production for the local market.

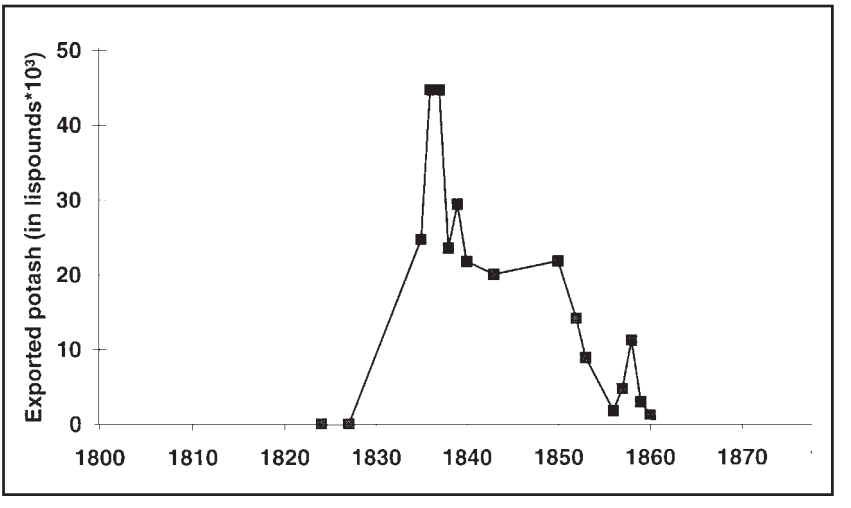

FIGURE 2. Potash export from the county of Västerbotten according to Tirén (1937). One lispound is equivalent to 8.5 kg.

PRE-INDUSTRIAL POTASH PRODUCTION ACCORDING TO HISTORICAL SOURCES

There are basically two types of historical document which describe the pre-industrial production of potash. The first are contemporary instructions written in order to teach farmers and other people how to make potash.[15] One of the most important persons in this field was assessor C. F. Plageman. He wrote several detailed instructions on how to proceed.[16] His recommendations can be summarised as follows:

1) the raw material should be old deciduous trees preferably with stem-rot;
2) the burning of the wood should take place in the forest and piles of wood should be gathered in places where there was good supply of raw material;
3) the wood must be raw and not dried, otherwise too much of the ash would be lost because of too intensive combustion;
4) the ash from the burning should be dissolved in water in large wooden barrels and the ash-solution thereafter be concentrated by evaporation in a large cast-iron kettle; and finally,
5) the resulting potash must be brought to a red heat by heating a large steel-plate with the raw potash on it.

Most of these instructions, written in the 18th and 19th centuries, are very detailed, with pedagogic drawings. It can be assumed that the instructions were produced with the sole purpose of teaching the public a new technology and promoting the potash production in different parts of the country.

Another source of information concerning potash production is in contemporary descriptions. A farmer, Abraham Hæggström, living near the town of Skellefteå in the early 19th century, recorded his economic activities in detail in the period 1836-1839. From his journal it is possible to extract quantitative data on the potash production from one farm at that time. The cutting and gathering of wood took place all year round, but mainly in late spring and early fall. The burning of wood and lenghty evaporation of the potash-water solution generally took place in the late fall and early spring. In total more than a hundred days per year was spent on the potash production, indicating that potash was a major source of income in this paricular case. A noteworthy circumstance is that he burned, or at least tried to burn, potash using different tree-species: conifers as well as broadleaves.

EXPERIMENTAL PRODUCTION OF POTASH

We conducted a field experiment to test the historical descriptions of potash production technology. We also wanted to furnish data on actual yield of potash burned and refined according to these descriptions. The field experiment was based on the method put forward by Plageman (1838), (1840) with some modifications according to Tirén (1937), Anon. (1944) and Pettersson (1959).[17] The experiment was carried out in the area where Tirén (1937) did his field work on the 19th century potash production in northern Sweden. Within this area Tirén dated several potash burning sites by analysing scars on surrounding trees from the 1830s and '40s.

Method

The experiment was conducted within a forest reserve at Kulbäcksliden experimental station in the county of Västerbotten. The new burning sites were placed near the old sites which were found and dated by Tirén. Approximately fourteen cubic metres (solid volume) of birch wood was cut in early september. It was left to dry slightly until September 19 when the burning took place. The wood was divided into three loosely piled stacks of 5.6, 5.6 and 2.4 cubic metres respectively. The size of the larger stacks corresponded to information from the 19th century descriptions. We also wanted to burn a smaller stack to see if the yield changed with the size of the stack. The stacks at each site were lit in the early morning of September 19 and burned during the course of that day. By the afternoon most of the wood had burned to ashes, but some charcoal remained.

FIGURE 3. Experimental potash production, stack of birch-wood being lit

In the morning of the next day the burning sites were still very hot. We therefore covered the sites with elevated tarpaulins and waited two days until we collected the ash. The ash was then brought to a small well where the soaking and subsequent evaporation of the potash-water solution took place. The ash from each stack was soaked in water in a large barrel and the solution was then filtered through spruce-twigs into a cast-iron kettle of 25 litres. The water was evaporated from the solution by burning under the kettle. The kettle was refilled 3-4 times from the barrel during the evaporation and the potash solution from each stack took approximately 18 hours to process. After the evaporation the raw potash, consisting of a greyish-brown crust, was re-

FIGURE 4. Reduction of the lye-solution in iron kettle

moved from the kettle and placed on a heated steel sheet. The potash was then calcined (i.e. heated for a few hours) in order to remove organic contaminations and other residue.

FIGURE 5. Calcination of the potash.

Results

Our experimental potash production yielded in total 2.3 kg potash from fourteen cubic metres of wood. The ratio between birch wood and potash was thus 0.16kg/m^3 solid volume of wood. The result of the small stack was approximately the same as the larger stack which we burned (table 1). During the experiment we observed some differences between the sites. The small stack burned more rapidly and more ash blew away during the burning. Conversely, we had to monitor the burning process more carefully at the larger stacks and replace wood which fell out of the fire. The time spent on the potash production comprised approximately four days (2 persons) of intensive work to produce 2.3kg of refined potash.

	Vol. of wood* (m^3)	**Ash yield (kg)**	**Potash yield† (kg)**	**Yield per m^3 of wood**	**Yield according to Tirén (1937)**
Stack 1	5.63	14.2	0.97	0.17	0.42
Stack 2	5.68	14.6	0.96	0.17	
Stack 3	2.46	6.3	0.39	0.16	

* Quantity of birch wood used in m^3 solid volume
† Yield of refined potash

TABLE 1. Experimental potash production at Kulbäcksliden in September 1992

DISCUSSION

Potash was an important forest-based export item from northern Sweden in the 19th century. The development of potash production, as indicated by the export from the county of Västerbotten, shows a rapid increase in the early 19th century and a similar decrease a few decades later (figure 2). Although there are no compiled records from other counties of northern Sweden, different sources indicate that the general development does not differ from that in the county of Västerbotten.[18]

The development of potash production in northern Sweden was strikingly similar to that in the United States and in the northern part of Finland, featuring an intensive potash campaign of comparativey short duration.[19] In all these cases the development was primarily driven by external demand and the technology had to be taught to local producers. The production was based on the burning of deciduous trees in the forest and the subsequent extraction of the potash.

Previous research concerning the potash production in northern Sweden has concluded that the impact on the forest landscape was great, and that shortage of the deciduous trees was the main reason for the decline of the production in the 1860s.[20] The main argument put forward was a theoretical estimate of the used amount of raw material which was compared to the state of the forest in the early 19th century. Similar, but less elaborate, theories regarding the impact of the potash production on the forest of southern Sweden in the 17th and 18th centuries have also been proposed.[21]

Our conclusion contradicts the theories presented earlier. The present study shows that it is not likely that shortage of raw material was the reason for the decline of the potash production in the county of Västerbotten in the 18th century. We base our theory on different evidence. The decline of the potash production in the county of Västerbotten coincides with the decline of the potash production in the United States and in northern Finland. Kreps (1931) discusses the decline of the production in detail and concludes that the causes were: 1) growth of the exploitation of other forest products, mainly lumber; 2) the substitution of potash with cheaper soda ash; and 3) new sources of supply of potash. The new supply of commercial potash was derived from mineral deposits in Germany which became commercially available in the 1860s.[22] A combination of factors thus caused the rapid decline of the potash industry in the United States and northern Finland, but real shortage of wood was not one of them. These factors also had an effect on potash production in northern Sweden which worked under the same conditions. Logging and tar-production increased substantially during the latter part of the 19th century.[23] Competition from cheaper German potash also affected the export-dominated production of northern Sweden. In the light of such a conclusion, a thorough analysis of the international potash trade may also shed new light on the rise and decline of potash production in southern Sweden in the 16th and 17th centuries. At that time

Russia was an important potash exporter,[24] whose activities may have influenced the Swedish export considerably.

Our experimental potash production yielded less than half the refined potash compared to the figure presented by Tirén.[25] Our experiment implies that the wood consumed by the 19th century potash campaign in Västerbotten was much higher, maybe twice as high as the amount Tirén calculated. This fact may be interpreted as evidence that there must have been a larger stock of deciduous trees at the time, although it does not necessarily prove that Tirén was wrong in his conclusion.

The ecological impact on the forest landscape casued by the potash campaigns is difficult to estimate. The large scale logging in the 19th century and its ecological consequences has received considerable attention.[26] The removal of old-growth pines and spruces and of dead and dying trees have been in particular focus, due to their importance as biological legacy in boreal ecosystems. It is quite possible that the potash campaign in northern Sweden had equivalent effects on the forest landscape, but these are obscured by subsequent forest exploitation.

The potash exploitation encompassed deciduous trees, primarily birches. The two birch species in northern Sweden, *Betula pendula* and *B. pubescens*, differ somewhat in their ecological preferences. *B. pendula* is primarily confined to dry sites, survives low-intensity forest fires and therefore often reaches a fairly high age, up to 300-400 years. *B. pubescens* often occupies moist habitats and seldom reach an age of more than 200 years. The abundance of these and other broadleaves (e.g. *Populus tremula*), and their distribution in the forest landscape of the 19th century, are uncertain. Hypothetically there were larger areas of relatively homogenous stands of deciduous trees originating from severe forest fires in the past.[27] Such areas in different successional stages could be one target for the potash production, because of the abundance of suitable trees within a limited area. Probably even more important were scattered larger birches (*B. pendula*) mixed with Scots pines on drier sites, which could have been a preferred forest type for potash burning. Recent research indicate that such forest was very common before the 20th century.[28] Birches in mixed coniferous stands (Scots Pine and Norway spruce) were probably also utilised. The historical descriptions of potash production furthermore implicitly recommended the use of trees with stem-rot and dead trees. The removal of a substantial part of the stock of deciduous trees clearly affected the forest landscape pattern in general and particularly the organisms dependent on such trees. Today many endangered and threatened species are dependent on old, dying or dead broadleaved trees in the forest landscape.[29] Broadleaved trees in general are considered to be keystone species in the conifer dominated boreal forest of northern Sweden. At the moment we are clearly only beginning to comprehend the long term consequences of human impact on the forest landscape.

Finally, an analysis of the impact on the forest ecosystem caused by the potash production in northern Sweden during the 19th century, can exemplify the general problems connected with the important analysis of man's impact on the forest ecosystems in a long perspective. Such analyses have to be based on knowledge of the quantitative impact of the specific activity and the state of the forest at the time.[30] Often it is not possible to access data which meet both these criteria and one of them therefore has to be estimated. This is exactly what Tirén did, since he had no information about the state of the forest when the potash campaign started. He calculated that the available resource of wood for potash production in the early 19th century was the same as the amount of birch wood in the early 20th century. Such an approach lacks precision and is not sufficient for an thorough analysis. Tiréns view was furthermore clearly influenced by the time when he presented his research, since the conclusions strongly emphasised the detrimental effects of past human forest exploitation. In the early 19th century the universal opinion among foresters and forest researchers was in favour of restoring the misused forests of northern Sweden. Tirén also lacked the longer perspective on changes in the state of Swedish forests which subsequent forest inventories and historical research have provided (figure 6).[31]

The lesson to learn is that historical analysis has to be based on data that take into account the dynamic nature of biological resources, in this case deciduous trees in a boreal forest landscape. These species are strongly dependent on forest

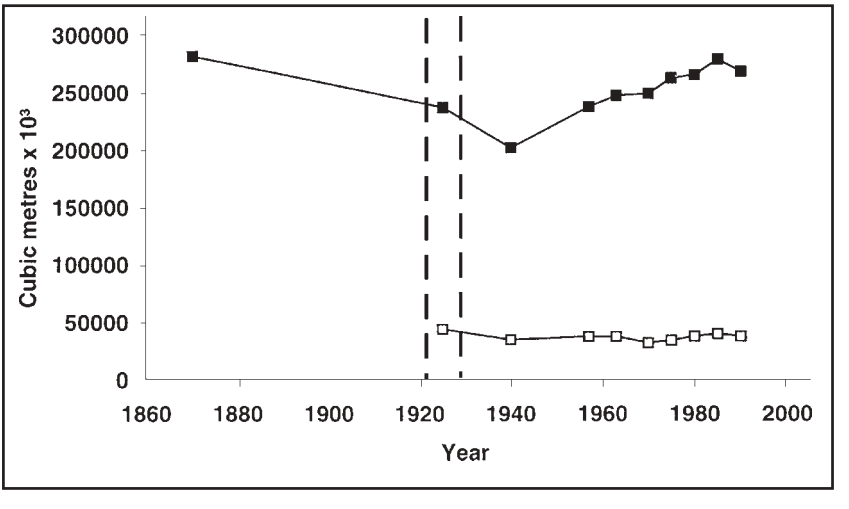

FIGURE 6. Changes in total standing volume (■) and standing volume of broadleaved trees (□) in the county of Västerbotten according to the National forest survey and Linder & Östlund (1991). The data available to Tirén within dotted lines.

fire perturbations for successful regeneration. Tiren's conclusion that the potash production had a great effect on the two birch species (*B. pubescens* and *B. pendula*) is still valid if other negative influences, such as a reduced fire-influence, are also taken into account as factors in the transformation of the Scandinavian boreal forest.

NOTES

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[1] Östlund1993: 16-21.
[2] Brandl 1992: passim, Tirén 1937: 251-254, Williams 1989: 74-75, Virrankoski 1987: passim.
[3] Åhman 1983: passim, Tirén 1937: 254, Östlund 1995: 97
[4] Tirén 1937: 258-259.
[5] Lindner 1935: 180.
[6] Åhman 1983: passim, Bodman 1950: 104-106.
[7] von Platen and von Sydow (Ed.) 1975:
[8] Åhman 1983: passim, Bodman 1950: passim.
[9] Åhman 1983: 133-135.
[10] Borgegård 1973: 20-22, Stridsberg and Mattson 1980: 55, Nyström 1982: 41-42.
[11] Borgegård 1973: 20-22.
[12] Tirén 1937: 252-253.
[13] Hellström 1917: passim.
[14] Tirén 1937: 254.
[15] Funck 1759, Rudensköld 1753, Scheffer 1759.
[16] Plageman, 1835, Plageman 1838.
[17] Plageman 1835, Plageman 1838, Tirén 1937, Anon. 1944, Pettersson,1982.
[18] Anon. 1944: passim, Pettersson 1982: passim.
[19] Kreps 1931: 640 ff., Roberts, 1972: passim, Virrankoski: 1987: 85-88, Williams1989: 74-75.
[20] Tirén 1937: 258-259.
[21] Åhman 1983: 133-135, Larsson 1989: 162.
[22] Kreps 1931: 647-648.
[23] Arpi 1959: passim, Borgegård 1973: passim, Bunte, Gaunitz and Borgegård 1982: passim.
[24] Kreps 1931: passim, Öhberg 1955: 130-131.
[25] Tirén 1937: 256-257.
[26] Hansson 1992 passim, Linder and Östlund 1992: 210-212, Östlund 1993: 21-23, Liljelund, Pettersson and Zackrisson 1992: 228-229.
[27] Zackrisson and Östlund 1991: 18-20.
[28] Östlund, Zackrisson and Axelsson 1996: passim.
[29] Anon. 1990: 53, Bernes (ed) 1994: 62-65.
[30] Zackrisson and Östlund 1993: 17.
[31] Linder and Östlund 1992: passim, Östlund 1993: passim.

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