

Using Oily Waste to Restore Productivity in a Severely Eroded Loamy Sand^{*}

M.C.P. Jarvis^{1 and 3}, V.O. Biederbeck², K.G. Hanson² and T.A. Fonstad³

¹ Research and Technology Centre, Imperial Oil Resources Ltd., Calgary, AB; ² Semiarid Prairie Agricultural Research Centre, Agriculture and Agri-Food Canada, Swift Current, SK and ³ Division of Environmental Engineering, University of Saskatchewan, SK

EXTENDED ABSTRACT

With progressive depletion of the more easily recoverable oil reserves in western Canada the volumes of waste generated during heavy oil production and processing are steadily increasing. The 600 million litres of heavy oil produced in 1998 accounted for 40% of the total oil production in all of Canada. The safe disposal of these heavy oil wastes has become an environmental issue. We believe agriculture can provide effective solutions for some of the oil and gas industry's disposal problems by utilizing the organic C-rich wastes to amend nearby areas of marginally productive cropland. Thus a recent field study in the Lloydminster region indicated that a single application of an EOR-type heavy oil production sludge to a Meota loamy sand, at 1 to 2% initial soil oil content, effected large and lasting increases in soil aggregation and an eventual 35 t/ha gain of humus through the microbial conversion of hydrocarbons. At present, the cultivated land base on the Prairies includes >3 million ha of sandy soils that are highly susceptible to erosion and are low in organic matter and productivity. Much of this marginal cropland could benefit from improvements in soil structure and humus content that can be realized through incorporation of organic, including petro-type, wastes. Consequently, the objectives of our field experiment at Richmond, SK are to generate benchmark data needed by regulatory agencies and by the oil and gas industry to jointly develop guidelines and protocols that will enable and control the future use of increasing volumes of hydrocarbon wastes - in an agronomically and environmentally sound manner - as soil amendments on private farmland in Alberta and Saskatchewan.

The AFIF-supported field study on a Hatton loamy sand near Richmond, SK consists of a 96 plot experiment with two cropping systems (i.e. fallow and cropped), two cereal crops (i.e. oats and wheat), three oily waste application levels (i.e., none, 1%, 2% soil oil

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content, wt/wt), two fertilizer treatments (i.e., none and best management practice), and four replications of all treatment combinations. The oily waste was applied and incorporated on November 5, 1997 by rototilling into the top 10 cm of the 2m x 12m plots. It originated from the Heavy Oil Upgrader of Consumers' Co-operative Refineries Ltd. in Regina SK and has a gross composition of 61% water, 31% hydrocarbons and 8% solids (clay). This sludge contains a total of 5,000 ppm of polynuclear aromatic hydrocarbons (PAH) with the two main PAHs being Dimethyl naphthalenes (1,500 ppm) and Methyl naphthalenes (1,300 ppm). In this study the oily waste is used as an amendment on sandy, erosion-prone farmland to induce stable soil aggregation and improve long-term crop productivity through the microbial conversion of hydrocarbons into humus. Consequently, timing and rates of N-and P-fertilizer applications were designed to optimize this soil microbial conversion process. Application of oily wastes to cropland to produce soil humus (stable organic matter) should sequester the bulk of the carbon in the soil rather than releasing it in form of CO₂ (i.e., one of the so-called 'greenhouse' gases) to the atmosphere, as occurs during burning or intensive 'land farming' of these wastes.

On this severely eroded loamy sand, that contained only 0.7% organic matter, the applied oily waste served initially as an effective 'glue' for binding and holding the sand grains together. Thus, by early spring 1998, the surface of the oiled plots showed no signs of topsoil loss to wind erosion while the unoiled control plots were littered with many rocks that became exposed as the surrounding topsoil had been swept away by strong Chinook winds. Rotary dry sieving showed a decrease in the wind erodible soil fraction (i.e., aggregates < 0.84 mm) of 9% where 1% oil was applied and a 13% decrease where 2% oil was applied. These reductions of the wind erodible fraction remained unchanged from spring 1998 to spring 1999. The resistance to erosion by water was also greatly increased as wet sieving, in spring 1998, indicated increases of 58% and 65% in waterstable aggregates where 1 and 2% oil had been applied, respectively. By spring 1999, the corresponding increases in waterstable aggregates were 44 and 71% due to soil incorporation of waste oil.

Enumeration of different types of microbes by soil dilution plating onto selective agar media indicated that the incorporation of oily waste sludge boosted most microbial populations when compared to unoiled control soil. The proportion of oil degrading organisms increased immediately severalfold and then decreased steadily over the next 11 months. The response to waste oil addition by soil bacteria and actinomycete populations occurred earlier than the response by filamentous fungi and yeasts. Heavy fertilization resulted in markedly reduced soil microbial populations and respiration, particularly at the 2% level of oil addition.

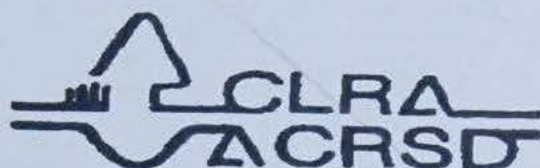
On April 15, 1998 the 48 plots on chemfallow were seeded to cereals, 24 plots to oats, cv. Calibre, and 24 plots to durum wheat, cv. Kyle. Due to poor emergence, probably caused by excessive moisture deficiency after the late fall rototilling and the lack of overwinter snowcover, all plots had to be reseeded on May 27, 1998. As a result of this late seeding and considerable early drought stress, crop growth and production was generally poor on

most plots. The results from manual harvest sampling in mid-August showed that on plots without oily waste-related fertilization, grain yield of oats was significantly increased at 1% soil oil content and was equal to the check yield at 2% oil. However, grain yields of durum at 1% oil were slightly lower than the check and at 2% oil in soil durum yield was severely depressed. On May 4, 1999, the previously fallowed 48 plots were seeded to oats and durum wheat and subsequent crop establishment was good with no adverse weather conditions. Plant emergence counts indicated there were no residual phytotoxic effects from the waste oil application on plant density or early development of either cereal. Manual sampling of the crop biomass at flowering, in mid-July, showed a two- to three-fold increase in durum production with 1% oil and a doubling of the check dry matter with 2% initial oil application. Oat biomass, production in the oiled plots was generally equal to the control and preliminary indications suggest that grain yields are markedly increased by waste oil application, particularly when combined with proper fertilization.

Our results, to date, confirm that some oil industry wastes can provide a very effective resource for the protection and improvement of sandy cropland and that this type of agricultural use could become a viable and cost-effective waste disposal alternative for the petroleum industry in western Canada.

Perspectives in Land Reclamation and Restoration

Presented by:



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Including the Canadian Land Reclamation Association's
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7:45 - 8:00 AM Bus Loading from Saskatoon Inn Lobby

8:00 AM Field Tour Departure (no delays)

7:00 - 10:00 PM Wine and Cheese, Registration

Wednesday, September 29th

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7:30 Registration

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Tracy Patterson (CLRA) and Theresa Salamone (SEIMA) n/a

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Resource Management n/a

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Session Chair: Lorne Veitch – Saskatchewan Agriculture and
Food, Lands Branch, Swift Current

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Todd Han, Saskatchewan Energy and Mines..... n/a

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