SOIL AND WATER MANAGEMENT FOR AGRICULTURAL PRODUCTION

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ABSTRACT

Mineral extraction by open cast method has been posing adverse environmental impact for agricultural production all over the world. The impacts can be traced to relative damage on soil texture and the pollution of water which are essential factors necessary for better yield of agricultural products. This paper citing a particular case history at the krivoe rog iron ore deposit, Ukraine Republic, examines possible ways to minimize this adverse environmental impact by application of adequate reclamation techniques with aim of not only bringing the land to its original relief status but also improving the soil texture and water for effective agricultural development.

INTRODUCTION

Most reclamation research is preoccupied with basic techniques required to solve the problems posed to agricultural development on hostile media. Thisalways leaves unformulated number of basic assumptions concerning the landscape goal of much of reclamation activity. Bradshaw (1975), on the value of heavy metal tolerance in the re-vegetation of metalliferous mine wastes pointed out that ore mining and processing of crude mineral ores produce areas of derelict land which are both visually unattractive and possible sources of environmental contamination. He further state that these problems are accentuated because the derelicts are often adjacent to agricultural land. Humphrey (1976), on analyzing Bradshaw findings confirmed that metalliferous wastes are very hostile to environment for agricultural development.

Bukrinski (1980), on the effect of opencast mining on rich agricultural land of Ukriane Republic of the former Soviet Union showed that the stripping and open pit mining of ore do not only pose visual

problems to the agricultural landscape but also the wind borne mineral dusts associated with ore deposit may travel 3-4 km downwind affecting vegetation pastures and grazing animals. Borovski (1983) on comprehensive study of beneficiation came to a logical conclusion that the involving plentiful supplies of water which become heavily polluted eventually finds its way to water course, species diversity thus leaving the stream fishless and devoid of algae or saprophytes growth and also render the water dangerous for human consumption.

Osemenam (1991), on environmental control from mine and mill waste found out that mineral dressing separates the gangue mineral from economic ore and in addition produces tailings that are allowed to settle out in ponds. This consequently poses a very serious pollution for the aquatic habitat.

Having visualized the adverse effect of mine waste on agricultural development, the author deem it necessary to carry out a comprehensive study to work out not only effective techniques by which the mined land that has bee excavated to a pit can be reclaimed but also how the soil texture and surrounding water effected by mine waste can be treated and managed for effective agricultural development.

THEORETICAL AND EXPERIMENTAL CONSIDERATIONS

Experimental work was undertaken at krivoe rog ore deposit where mining was carried out by open cast system. The deposit covers a land area of about 25km^2. This encroaches into a vast agricultural land of the district and streams marked out for irrigation.

The problem of the restoration of the land areas spoiled by open cast mining of mineral deposit is of crucial importance and this call for effective management of soil and water. The land reclamation was carried out by engineering and biological techniques.

The engineering reclamation consists in the preparation of land territories freed after open cast mining. In its broad sense it includes the following

- Preservations of upper soil layer.
- Leveling of dumps.
- Construction of drainage net works.
- Chemical melioration of the soil composition.
- Covering of the leveled surface with a layer of fertile soil.

The area of land covered by the experimental work was 1.0 km^2. On

restoration of the iron strip land; the area of land was first carefully surveyed, and topographically mapped (fig.1). This was followed by spoil placement and grading. Here grading spoil to a specific shape was required. This varies from minimal grading to its original contour. A cross-section and isometric view of the contour strip mine showing graded benches, pond, out slope and windrow of vegetation is shown in fig.2. It should be noted that the grading was carried out in such a manner to a rolling topography. On reclamation of the stripped land one moved a further step to re- vegetate the land in order to improve the soil contents. Under the soil conservation service of the former Soviet Union, Department of Agricultural the author proceeded with SCS (Soil Conservation Service) trial; paramount to determine species of plant. Some of the plans were established from vegetative materials. All were planted in rows across the plot. The seed were planted in a trench above 12-20mm depth and were covered with loose soil. The plants were set slightly deeper than grew in the nursery and they were watered at the time of planting. Fertilizer and lime were broadcast after planting. There were four fertility variables.

These were:

- 1681kg of 6-12-12 fertilizer and 4483kg of agricultural limestone per hectare.
- 1681kg of 6-12-12 fertilizer per hectare.
- 4483kg of agricultural limestone per hectare
- No fertilizer or agricultural limestone.

The fertility treatments were applied across the plant rows. One of the site received pine straw mulched at the rate of 4483kg per hectare. The other site was left un mulched. The plants used in the evaluation were:

ALDER, HAZEL	Alnus rugosa (du Roi) spring
AUTUMOLIVE	Elagnus umbellate thumb
BAHAIGRASS, PENBSACOLA	Paspalum notum saurae parody
BAHIAGRASS, WILMINGTON	Cynodon dactylon
BERMUGRASS, COMMON	Cynodon dactylon
BLYESTEM KING RANCH	Andropogon ischaemum
BROOMSEDGE	Andropogon virginicus

BRUNSWICKGRASS AMCOBAE	Paspalum nicorae parrodi
BUTTONBUSH,COMMON	alnathus accidentialis
CARPETGRASS	xonofrus affinis chase
COTTONSEDGE, VIRGINIA	riopherum virginnicum
GIANT REED	undo donax
INDIGO FALSE ANIL	ndigofra pseudotinctoria
JOINTVETCH SENSITIVE	Aescchynomene
KUDZU 23	Pueraia thunberginaa
LESPEDEZA KOBE	Lespedeza striata
LESPEDEZA, WEEDING	Eragrostis curvula
MARIGOLD, TALL	Tagetes minuta
PEANUT, FORAGE	rachis sp
PEANUT, ANNUAL FORAGE	rachis sp
LOCUST, ARNOT BRISTLY	Robinia fertihis aske
SESBANIA	esbania sp
SUNAC, SMOOTH	Rhus glabra
SWITCHGRASS, PANGBURN	Pnicum virgatum
TRUMPETCREEPER	Caspsis sradicaus
WILLOW, SAND BAR	Sabix interior rowlee

RESULT/DISCUSSIONS

The quickest germination and overall best stand was under mulched conditions.

Although good stand were obtained initially on the unmulched site, most of the plants lacked vigor and the stand weakened as the summer passed. The exposed surface of soil material tended to dry out readily although the moisture seemed fair at a depth of 12 to 20mm.

After about 10 days without rain, the surface cracked quite deeply and moisture became limited. Generally, only Arnot bristly locust from plants has given satisfactory results on its unmulched site. About half of the plants persisted, but they made little growth. The best automotive from plants and common Bermuda grass, weeping love grass, from seed.

Plant performance on the mulched site was dramatic. Stands were poor where the mulch was blown away by wind. The germination of most of the seeded plants was good. Differences in plant vigor

according to fertility treatments became pronounced as the season progressed. As the season progressed, it became increasingly evident that fertilization was necessary to maintain a stand of plants.

Growth and development approaching normal conditions were obtained only when fertilizer and much were applied.

There was little or no growth in the unfertilized areas contrasted with fair growth of most of the plants in the fertilized area in the first year.

Nitrogen, at the rate of 56kg/ha was applied to the grasses on the unmuiched site in the second year, but there was no marked improvement in growth or cover.

The application of agricultural limestone appeared to have no immediate effect. A brief discussion of species that performed best on mulched site follows:

i. **Automotive:** was planted using seed. This was a failure with only one plant in two sites surviving after two years. Automotive plants were set out. Very little growth occurred in the first year. In the second year, growth was good. After four years these plants had grown to over 1.8m tall and are producing food for wild life. The ability of this plant to fix atmospheric nitrogen favors its success. It is being looked upon as a wildlife food plant to be grown in association with other plants which can be deepened upon for early erosion control.

ii. **Common Bermuda Grass:** came up to a good stand and spread rapidly the first year. It gave the quickest surface protection of any of the plants. It continued to spread and to provide very little new cover. It produced seed in both years.

iii. **Kobe Lespedeza:** came up to a thick stand in the fertilized area and made very good growth. Kobe lespedeza shows outstanding promise for quick establishment and cover on this site. It is also useful as a wildlife food plant.

iv. **Lericea Lespedeza:** came up well and grew vigorously in the fertilized area. It produced seed and some volunteers have been observed.

v. **Vigata lespedeza:** became well established with fair vigour in the fertilized area. It grew moderately well in the first year and better in the succeeding years. The leaf residue from this perennial plant provides ground cover and mulch. It

is a good species for use in stabilizing mine spoil banks.

vi. **Weeping Love Grass:** was quick to germinate and vigorously. Love grass seed was transported by run off water and germinated in many plots where it was not planted. Excellent growth and cover resulted everywhere it lodged in fertilized plots.

vii. **Bristly Locust:** was easier to establish from seed than from plants. The seedling plants showed good initial vigour. They grew to about 1.5m in height when fertilized and only 15cm in height when not fertilized. The seedling plants attained about as much size in the first year as the nursery grown plants. All plants in the fertilized area produced seed.

viii. **Pangburn Switch Grass:** produced a good stand and the plants were vigorous in the first year. On the fertilized area they remain fairly vigorous and have slowly spread by tillers. Seedling had produced a few volunteers. Pang burn switch grass may have value on these sites.

ix. **Thunberg lespedeza and bi-colour lespedza:** were grown from seed. The plants were vigorous providing food and cover for wildlife.

Having solved the problem of vegetative of the reclaimed agricultural land, the author went further to study the conservation of polluted surrounding water from acid mine drainage. When iron was mined the iron disulphide (FeS_2), occurring as pyrite, in the iron and associated state are exposed to atmosphere as pyrite, in the iron and associated state are exposed to atmosphere and readily oxidize to series of hydrous iron sulphates.

These compounds are soluble in water and produce mine drainages that commonly have pH values around 2. In this respect the surrounding streams of the krivoe iron deposit were subjected to pollution from acid mine drainage.

This pollution is controlled by injecting any alkaline solution into the affected stream. This neutralizes the acidity of the streams and hence making it fit for agricultural drainage.

CONCLUSION

For effective soil management in an open cast mine district, there is immediate need to address the issues of landscape and soil texture reclamation which have been tampered with as a result of mining activities at the districts. The paramount techniques of land reclamation in the above case are by method of cutting and filling. There is also need for vegetative cover which goes a long way to improve the soil texture for future agricultural development. The continuous injection of alkaline solution into the polluted stream by acid mine drainage reduces the toxicity of the stream and hence renders the stream fit for agricultural

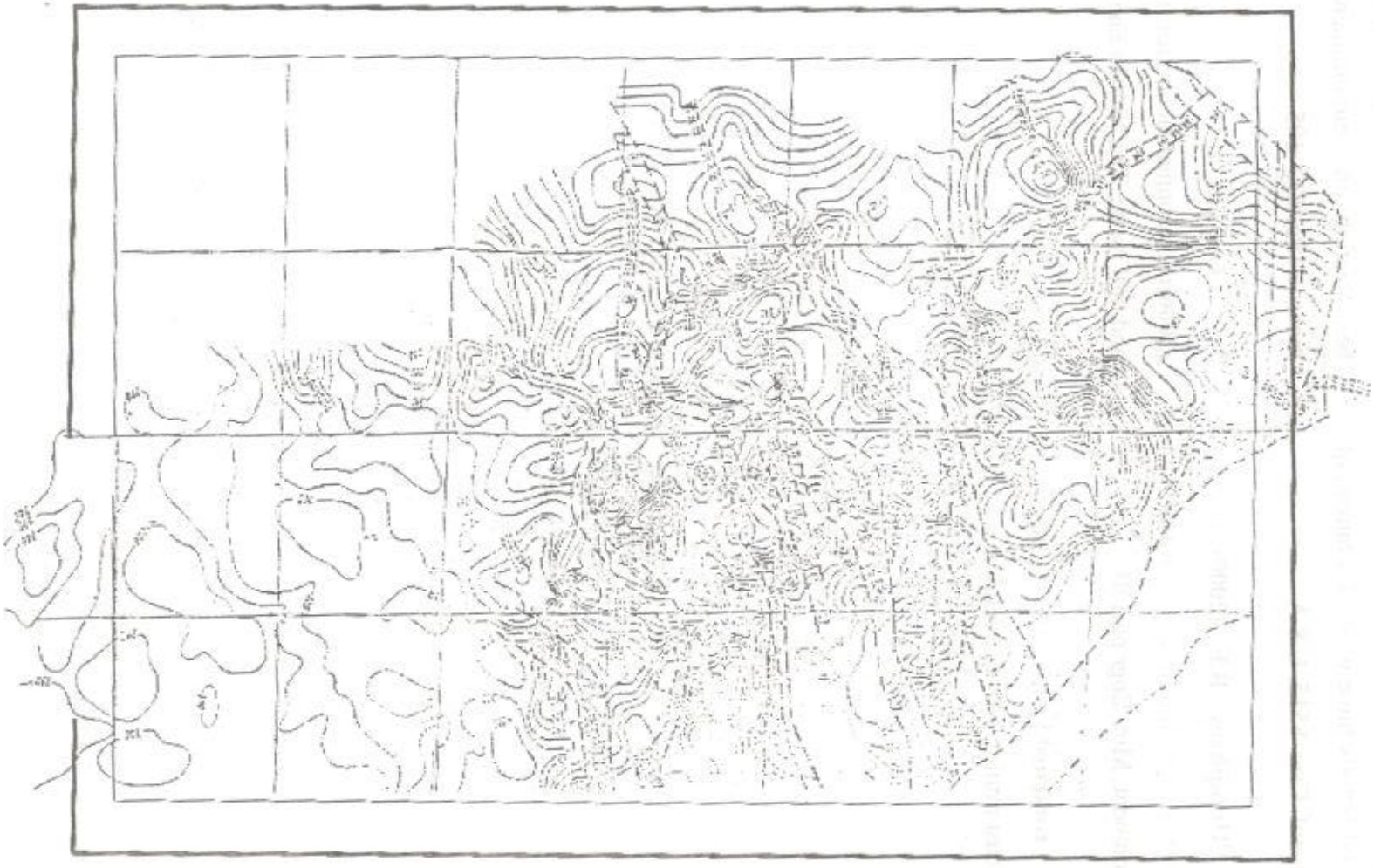

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Fig: 1. Krivoe rog iron ore deposit Ukraine Republic

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