# סקירת שימושי אפר פחם בחקלאות בעולם


פברואר 2013

דן שריקי

מנהל מרכז מידע, מנהלת אפר פחם

# שימושים

Welcome to the

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European Coal By-products Association (ECOBA)

UK Quality Ash Association (UKQAA)

Polish Union UPS

Information and Analytical Centre "Ecology of Power Engineering of MPEI - Russia

Canadian Industries Recycling Coal Ash (CIRCA)


National Coal Ash Board (NCAB) - Israel

American Coal Ash Association (ACAA)

Japan Coal Centre (JCoal)

South African Coal Ash Association (SACAA)

**Visit the web sites of the members of the WWCCPN**

The members of the WWCCPN can tell you all about the use of CCPs in each country by clicking on their flags.

Ash Development Association of Australia (ADAA)

Made with Xara

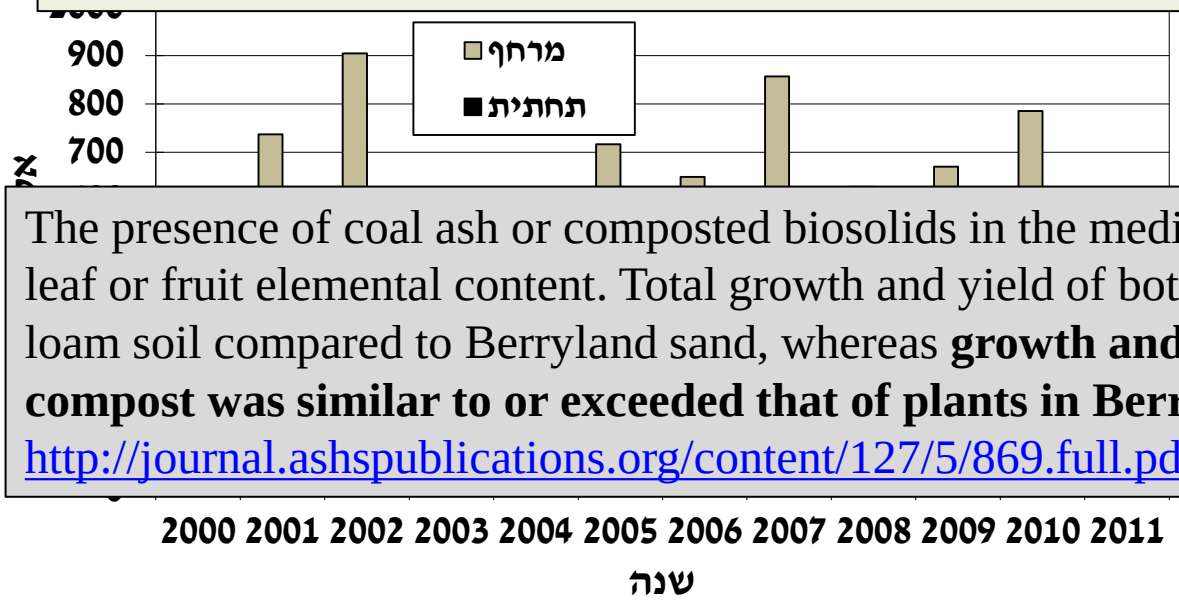
# כמויות- ארה"ב (ACAA)

## Agriculture

Bilski et al., 2011. Environmental health aspects of coal ash phytoremediation by selected crops.

1) The additions of 10, 20 and 30% of FA to the soil **supported plant germination and growth**;
2) 2) Preliminary results of chemical analysis of FA and harvested young plants implicate that **plants do not accumulate toxic amounts of heavy metals, even grown on media containing 100% FA**;
3) These results indicate that coal **FA might be used as a plant growth media supplement**.

http://journal.ashspublications.org/content/127/5/869.full.pdf




Black & Zimmerman, 2002. Mixture of coal ash and compost as substrate for Highbush Blueberry

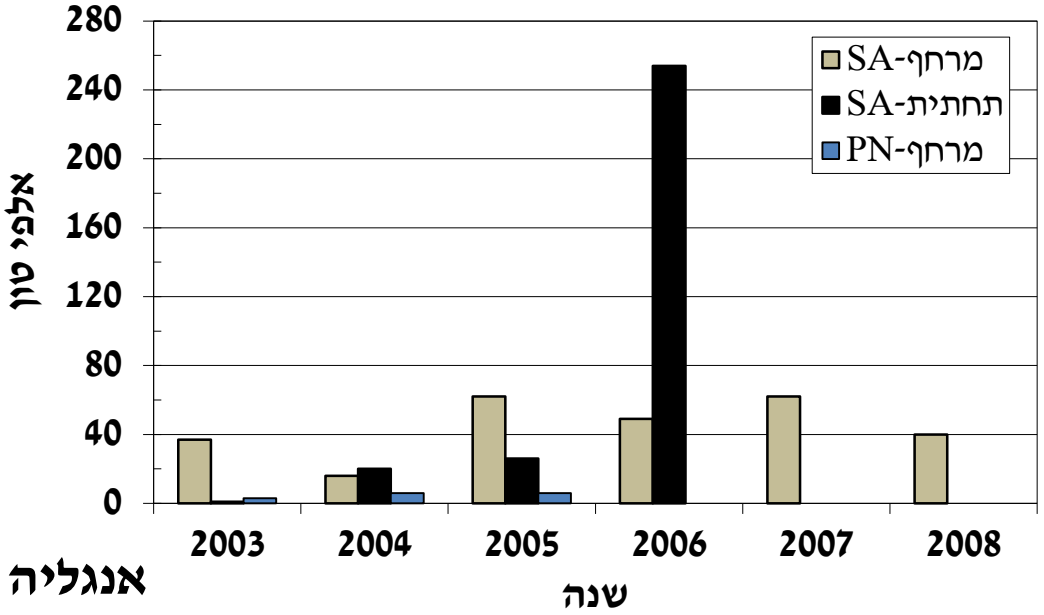
The presence of coal ash or composted biosolids in the media **had no detrimental effect** on leaf or fruit elemental content. Total growth and yield of both cultivars was reduced in clay loam soil compared to Berryland sand, whereas **growth and yield of plants in coal ash-compost was similar to or exceeded that of plants in Berryland sand**.

http://journal.ashspublications.org/content/127/5/869.full.pdf

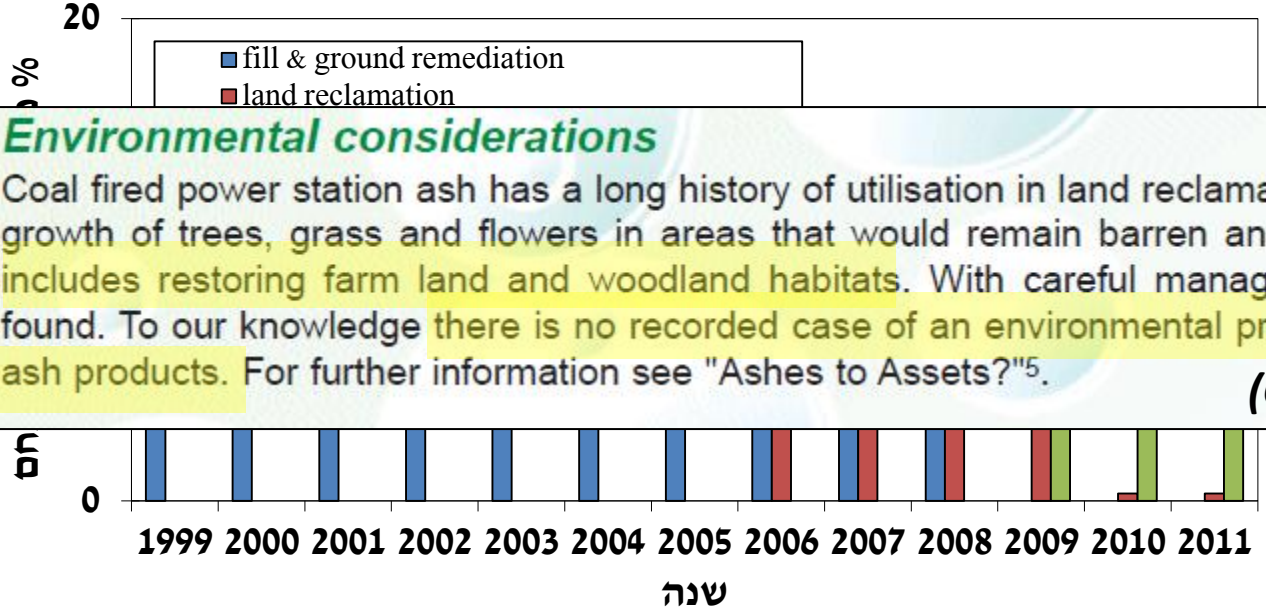
# כמויות- אירופה

**SA- soil amendment**
**PN- plant nutrition**

## איחוד אירופי (ECOBA)




## אנגליה (UKQAA)




***Environmental considerations***

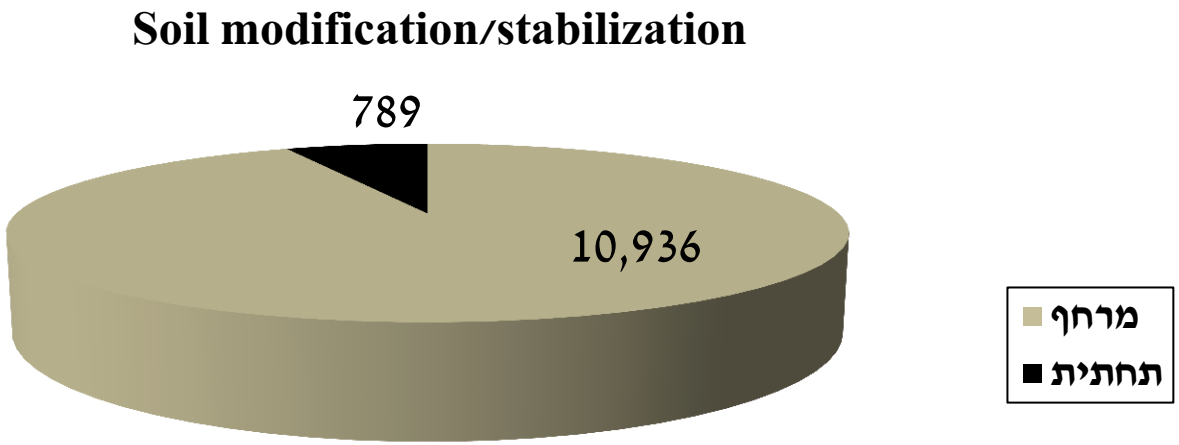
Coal fired power station ash has a long history of utilisation in land reclamation, helping to encourage new growth of trees, grass and flowers in areas that would remain barren and toxic. The list of applications includes restoring farm land and woodland habitats. With careful management no problems should be found. To our knowledge there is no recorded case of an environmental problem being caused by coal fly ash products. For further information see "Ashes to Assets?"[5].

***(General UKQAA Brochure)***

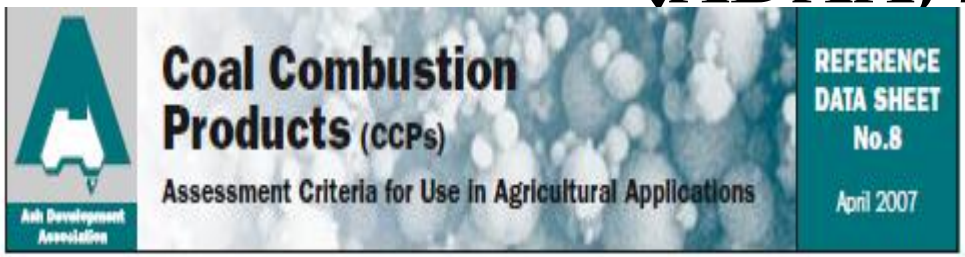
# כמויות אפר פחם – יפן, אלפי טון (JCOAL, 2006)

| Item | | Electric power utilities | General industries | Total |
|---|---|---|---|---|
| Agriculture, forestry & fisheries | Fertilizer | 50 | 22 | 72 |
| | Soil improvement | 10 | 79 | 89 |
| | Total | 60 | 101 | 161 |

# כמויות (טון)- אוסטרליה (ADAA, 2010)



# אוסטרליה – קריטריון מוצע לשימוש באפר בחקלאות (ADAA, 2007)




| Elements | Procedure | Criteria | Reference | Frequency |
|---|---|---|---|---|
| **Total Metals- M17 Metals[1]** | USEPA 200.2 | Cd (10mg/kg)<br>Pb (100 mg/kg)<br>Hg (5mg/kg) | Fertilisers Act 1985 (NSW) | Annually |
| **Leachable TCLP Metals- M17 Metals[1]** | USEPA 1311 | Various | Environmental Guidlines:Assesssment Classification and Management of Liquid and Non -liquid Wastes, DEC 1999 | Annually |
| **Boron** | CaCl2 Extraction Method | 60 mg/kg | The fly ash and bottom ash from burning NSW or Queensland coal exemption 2006 (NSW), Table 2 | <1000 tonnes,three (3) times per annum (minimum)[2] |
| **Electrical Conductivity ECse** | Method 104, Guidlines on Laboratory Analysis of Potentially Contaminated Soils NEPM 1999 | 4 dS/m | The fly ash and bottom ash from burning NSW or Queensland coal exemption 2006 (NSW), Table 2 | <1000 tonnes,three (3) times per annum (minimum)[2] |
| **Dioxin and Furans** | USEPA 1613B | 100ng/kg | Referenced from limits for the land application of biosolids in Europe | Annually[3] |
| **Chemical Oxides** | XRF | Report | | Every 3 years[4] |

1 M17 metals: Ag, As, Ba, Be, Cd, Cr, Cu, Ni, Pb, Sb, Tl, Zn, Se, Hg.

2 Where more than 1000 tonnes of ash is provided to processors or consumers in total, suppliers must test at least three times a year plus once every 1000 tonnes (See s 11.5.2 of the Exemption).

3 Annually for first 3 years and subsequently, once every 3 years.

4 Or on a change of input that is likely to affect the components in the ash (see s 11.1.3 of The fly ash and bottom ash from burning NSW or Queensland coal exemption 2006 (NSW)

The purpose of this reference data sheet is to provide guidance to producers, suppliers and users with industry agreed acceptance criteria and methodologies used to assess the suitability of CCPs prior to use in agricultural, horticultural and forest ecosystems.

# דשן מינרלי מסחרי- אפר מרחף עם חומר אורגני, אוסטרליה (ADAA, 2007)

האפר כמקור למיקרו- ומקרו-נוטריינטים, בעיקר קלציום שמצוי במחסור בקרקעות אוסטרליה

coal ash. The solution is a unique blend of micro-organisms that thrive in a specific ratio of carbon and minerals (brown coal and ash). The new product, called Life-Force® will be manufactured on site at Hazelwood Powerstation which boasts the best analysis ash for agricultural purposes. The special

**New Bio-Ash**
**Fertiliser**

QLD-based company, Nutri-Tech Solutions (NTS), have recently developed a new bio-fertiliser based upon carbon, minerals and micro-organisms. NTS have been researching biological techniques to solubilise humic and fulvic acid from brown coal while maximising the mineral punch of coal ash. The solution is a unique blend of micro-organisms that thrive in a specific ratio of carbon and minerals (brown coal and ash). The new product, called Life-Force® will be manufactured on site at Hazelwood Powerstation which boasts the best analysis ash for agricultural purposes. The special Life-Force® inoculum includes beneficial fungi which boost carbon sequestration in the soil and a range of task-specific bacteria species. These inocula contain nitrogen fixers, phosphate solubilisers and predatory organisms, which together can boost both the productive and protective qualities of soils. Life-Force® from NTS features luxury levels of plant-available calcium, magnesium, sulphur and silica. It also contains over 70 other minerals, many of which have been linked to plant health and crop quality.

*Coal ash in Life-Force®, has a huge role to play in the essential soil remineralising that is required to produce superb food quality.*

*The Life-Force® blend contains several species of bacillus for plant growth stimulation and protection.*

Calcium is the most common deficiency in Australian agriculture and Life-Force® is designed to increase the uptake of this important mineral. There have been several published papers on the capacity of humic and fulvic acid (found in Life-Force®) to increase calcium uptake. The calcium found in coal ash (a combination of calcium oxide and hydroxide) is much more soluble and plant-available than calcium in limestone (calcium carbonate). In fact, limestone contains just 5 kilograms of soluble calcium per tonne while coal ash contains over ten times that amount. There are also micro-organisms included in the Life-Force® blend which aid in the retention and availability of calcium.

**For more information about Life-Force® phone 1800 425 663.**

http://www.adaa.asn.au/documents/Coal_Ash_Matters_Nov_07.pdf

# דרום אפריקה

2005 World of Coal Ash (WOCA), April 11-15, 2005, Lexington, Kentucky, USA http://www.flyash.info

## ...opment of Coal Ash Utilisation

Field and laboratory trials have shown that after an initial addition of ash the vegetative yield has been maintained for several years at levels elevated well above that of other treatments. Various crops have been tested (corn, beans, legumes, grasses, etc.)

Fly ash is essentially the ...
regarded as a 'natural' addition to soil.

With much of the agricultural land in the proximity of the power stations being acidic, ... soil ameliorant has proven to significantly increase crop

The use of fly ash to pasteurise sewage sludge has been demonstrated. The resultant product has also proven to be an excellent soil ameliorant. Although not yet commercialised in South Africa, similar technologies are being successfully applied elsewhere in the world.

This finding ... currently underway has shown that ...
cover was rapidly established and maintained.

The rehabilitation of gold mine spoil with fly ash has proven to be more cost-effective than the conventional method using limestone.

The use of fly ash to pasteurise sewage sludge has been demonstrated. The resultant product has also proven to be an excellent soil ameliorant. Although not yet commercialised in South Africa, similar technologies are being successfully applied elsewhere in the world.

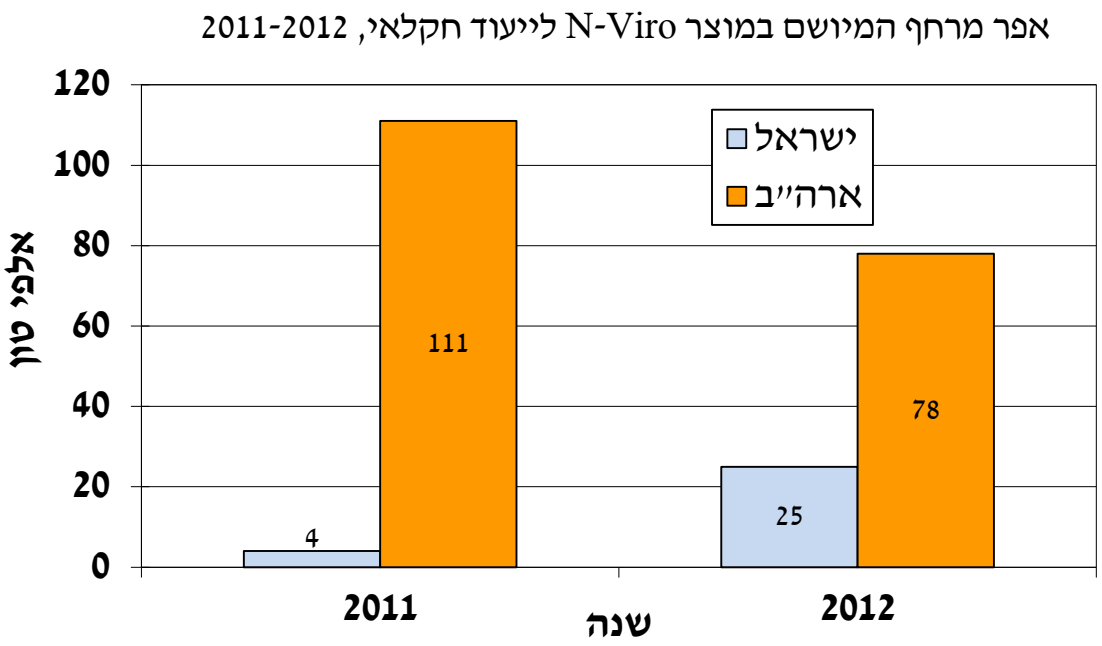
# דרום אפריקה

2001 International Ash Utilization Symposium, Center for Applied Energy Research, University of Kentucky, Paper #80. 

http://www.flyash.info

The use of a soil ameliorant based on sewage sludge and fly ash has definite agricultural potential. The ameliorant has promising liming qualities, improving the pH and maintaining it for a minimum of 18 months as recorded to date. For how long this effect will persist is still to be determined. It is also a promising plant yield enhancer. From the results of these raised bed trials it can be concluded that SLASH has a long term residual effect, and can be seen as a slow release source of elements required for plant growth.

# טיפול אלקליני בשפכים




בשנים אלו נעשה שימוש ב- 200-300 אלף טון אפר מרחף בשנה במתקנים של חברות אחרות לטיפול בשפכים בארה"ב, מתוכם 80% לפחות יועדו לחקלאות.

# מחקרים

- National Agricultural Library, US Department of Agriculture

532 מחקרים בין 1998-2009 (נסקרו 250) בנושא שימושי CCP בחקלאות בכללם אפר מרחף עם/ללא בוצת שפכים ודשן פרות (יבול ; ייצוב ושיפור מבנה הקרקע ; כימיה של הקרקע ; מתכות קורט ויסודות הזנה בגידולים, בקרקע ובתשטיפים ; היבטים מיקרוביאליים בקרקע ; מחלות בקרקע ובצמחים)

**מדינות** : ארה״ב, דר׳ קוריאה, סין, שבדיה, בוסניה והרצגובינה, דרא״פ, הודו, יפן, אוסטרליה, פולין, אנגליה, תאילנד, גרמניה...

**גידולים אכילים** : גזר, בננה, כרוב, לפת, צנונית, אפונה, תרד, כוסברה, חסה, עגבניה, חציל, חיטה, אורז בוטנים, צמחי נוי, קנה סוכר, אורז, חמניה, תות, שיבולת שועל, תירס, אוכמנית, במיה, בצל, כרובית, אפונה סינית (green gram), פפאיה, ragi, black gram, תפו״א, סויה, צ׳ילי...

**אחרים** : Acacia nilotica, Spathiphyllum, עולש, טבק, כותנה...

**סביבה** : איכות מי תהום לא נפגעה מהוספת אפר מרחף (למשל Adriano et al., 2002, עומס מכס׳ 1120 t/ha)...

**בדיקות רדיו׳ מתחת לסף גילוי, הודו, Yeledhalli et al., 2008**

http://www.nal.usda.gov/wqic/Bibliographies/industrial-byproducts-04section.pdf

# מחקרים - הודו

- Kumar et al., 2005

#### 4.2.1.1 Impact of fly ash on crop yield

The results on the yield of different crops grown with fly ash in various soil types are included in Table 7. It is evident from the results that the addition of fly ash (10 - 200 tonne per ha) increased the yield of different crops from 10-40%. Thus the use of fly ash in agriculture has proved to be economically rewarding.

**Table 7: Effect of fly ash application on Yield of various Crops at different locations**

| Soil Group | Location | Application rate | Crops | Percent yield increase |
|---|---|---|---|---|
| Alluvial Soil | Dadri (UP) &IARI (Delhi) | 10-20 t/ha | Wheat, Mustard, Rice, Maize | 6-18 |
| Alluvial Soil | Hissar (Haryana) | 20% soil: ash (w/w) | Pearl Millet, Wheat | 32 |
| Alluvial Soil | Murshidabad (W. B.) | 200 t/ha/3yrs (one time application) | Wheat, Rice | 29 |
| Black Soil | Vidarbha Region (Maharashtra) | 10-15 t/ha | Seed Cotton, Sorghum, Gram, Soybean, Summer Groundnut, Wheat | 10-46 |
| Red Soil | Raichur (Karnataka) | 30-60 t/ha/3yrs (one time application | Sunflower, Groundnut | 10-26 |
| Black Soil | Raichur (Karnataka) | 30-60 t/ha/3yrs (one time application | Sunflower, Maize | 22-42 |
| Red lateritic Soil | Coimbatore & Vridhichalam (Tamilnadu) | 40 t/ha | Rice, Groundnut | 14-25 |
| Lateritic Soil | Kharagpur (W. B.) | 10 t/ha | Kharif Rice, Mustard | 12 |
| Red Soil | Birbhum (W. B.) | 200 t/ha/3yrs (one time application | Kharif & Boro Paddy, Potato | 31 |

http://c-farm.org/002.pdf

# מחקרים - הודו

**Table 12(a): Effect of application of fly ash on concentration of available heavy metals (ppm) in Control Soil and Fly ash Treated Plots after harvest of paddy & wheat during 1996-2002: Site-Bakreshwar (W.B)**

| Lead | | Nickel | | Selenium | | Chromium | |
|---|---|---|---|---|---|---|---|
| Control | FA (200T/ha) | Control | FA (200T/ha) | Control | FA (200T/ha) | Control | FA (200T/ha) |
| 3.60 | 3.70 | 0.50 | 0.65 | 0.15 | 0.20 | 0.20 | 0.20 |

**Table 12(b): Effect of application of fly ash on concentration of available heavy metals (ppm) in Control Soil and Fly ash Treated Plots after harvest of paddy & wheat during 1996-2002: Site-Bakreshwar (W.B)**

| Cadmium | | Arsenic | | Mercury | | Cobalt | |
|---|---|---|---|---|---|---|---|
| Control | FA (200T/ha) | Control | FA (200T/ha) | Control | FA (200T/ha) | Control | FA (200T/ha) |
| 0.03 | 0.03 | BDL | BDL | BDL | BDL | 0.04 | 0.06 |

BDL - Below Detectable Limit

# מחקרים - הודו

**Table 14 (a) : Effect of application of fly ash (FA) on concentration (range) of heavy metals in Grains & Straw (ppm): Site-Bakreshwar (W.B)**

| | Lead | | Nickel | | Selenium | | Chromium | |
|---|---|---|---|---|---|---|---|---|
| | Control | FA (200T/ha) | Control | FA (200T/ha) | Control | FA (200T/ha) | Control | FA (200T/ha) |
| **Paddy (96-2002)** | | | | | | | | |
| Grain | 0.6-0.8 | 0.7-0.9 | 0.4-0.6 | 0.6-0.8 | 0.4-0.5 | 0.6-0.7 | 0.7-0.8 | 0.7-0.9 |
| traw | 0.7-0.9 | 0.8-0.9 | 0.7-0.8 | 0.8-1.0 | 0.2-0.3 | 0.3-0.4 | 0.7-0.9 | 0.7-0.9 |
| **Wheat (96-2002)** | | | | | | | | |
| Grain | 0.2-0.3 | 0.2-0.3 | 0.2-0.3 | 0.3-0.4 | BDL-0.2 | BDL-0.3 | 0.4-0.5 | 0.4-0.6 |
| Straw | 0.2-0.4 | 0.3-0.4 | 0.2-0.3 | 0.3-0.4 | BDL-0.1 | BDL-0.2 | 0.4-0.5 | 0.4-0.5 |

**Table 14 (b): Effect of application of fly ash on concentration (range) of Heavy Metals in Grain and Straw (ppm): Site Bakreshwar (W.B)**

| | Cadmium | | Arsenic | | Mercury | | Cobalt | |
|---|---|---|---|---|---|---|---|---|
| | Control | FA (200T/ha) | Control | FA (200T/ha) | Control | FA (200T/ha) | Control | FA (200T/ha) |
| **Paddy(96-2002)** | | | | | | | | |
| Grain | < 0.5 | < 0.5 | BDL | BDL | BDL | BDL | BDL-0.04 | BDL-0.05 |
| Straw | < 0.5 | < 0.5 | BDL | BDL | BDL | BDL | 0.03-0.05 | 0.04-0.06 |
| **Wheat (96-2002)** | | | | | | | | |
| Grain | < 0.5 | < 0.5 | BDL | BDL | BDL | BDL | BDL-0.04 | BDL-0.04 |
| Straw | < 0.5 | < 0.5 | BDL | BDL | BDL | BDL | BDL | BDL |

# מחקרים - הודו

### 4.2.3.2. Toxicological Studies

The detailed laboratory and clinical studies have been taken up at National Institute of Nutrition (NIN), Hyderabad, under Indian Council of Medical Research (ICMR), Ministry of Health, GOI, to evaluate the produce grown on fly ash treated plots for the toxicological impact. The laboratory analyses reaffirm the earlier findings of insignificant impact of fly ash in respect of heavy metal contents in agricultural produce. Clinical evaluation has also been done through haematological and histopathological studies. Two groups each of 12 rats (weanling WNIN) & 12 mice were taken for the study, as per WHO protocol. The test groups were fed with produce grown on fly ash treated soil and the control group of animals were fed with same composition of food from control plot. The physiological data regarding weight, growth, etc were recorded at regular intervals. Blood & tissue samples were tested as per the protocol. Animals were scarified and various organs tested. The tests & evaluation revealed that there is no toxicological impact to any of the organs of both rats and mice fed on crop produce grown with fly ash.

The photographs/ scan of brains, kidney, liver, heart of animals fed with crop produce grown on fly ash treated soils, placed below, do not show any change / impact.

# מחקרים - הודו

### 4.2.3.4 Evaluation of Radioactivity

Samples of fly ash, soil, grain and biomass from fly ash treated plots as well as the control plots under the projects undertaken/ supported by FAM/ FAUP have been evaluated for their radionuclide contents at Institute Of Physics (IOP), Bhubaneshwar, Department of Atomic Energy, GOI. The results presented in Tables 16 & 17 clearly show that application of fly ash has no significant impact on field soil, and agricultural produce and biomass.

**Table 16: Activity Levels (Range) of gamma emitting radionuclides in flyash, field soils and flyash amended soils (Bq Kg-1)**

| | $^{40}K$ | $^{226}Ra$ | $^{228}AC$ |
|---|---|---|---|
| Dry fly ash | 290-350 | 70-90 | 90-110 |
| Pond ash | 280-320 | 65-85 | 80-100 |
| Field soil | 170-200 | 30-50 | 40-60 |
| Fly ash amended soil | 200-300 | 40-60 | 50-70 |

**Table 17: Activity levels (Range) of gamma emitting radio-nuclides in grains & straw of paddy & wheat crops (Bq Kg-1 ): Site: Bakreshwar, (W.B)**

| Period | Treatment | Activity | | |
|---|---|---|---|---|
| | | $^{40}K$ | $^{236}Ra$ | $^{238}AC$ |
| Paddy & wheat Grain (1996-2002) | T1 | 60-90 | 0.3-0.4 | 0.5-0.7 |
| | T4 | 65-100 | 0.4-0.7 | 0.7-1.0 |
| | T7 | 67-100 | 0.4-0.7 | 0.7-1.0 |
| Paddy & wheat straw (1996-2002) | T1 | 10-25 | 03.04 | 0.6-0.7 |
| | T4 | 15-30 | 05.07 | 0.7-0.9 |
| | T7 | 15.30 | 0.5-0.7 | 0.7-0.9 |

Note: T1: Control (without fly ash), T4 : Fly ash application @ 200 t/ha (one time),
T7 : Pond ash application @200 t/ha (one time)

תודה רבה

# מאגרי מידע

- סקירת שימושי אפר פחם בחקלאות- פרופ׳ אורי מינגלגרין, המכון למדעי קרקע ומים, מרכז וולקני, 2003
- מחקרים ומאמרי review באינטרנט
- אתרי אינטרנט של ארגוני אפר בעולם (WWCCPN)