TABLE 1. Indigenous plant species grown in flyash contaminated land a promising phytostabilization (P-S) and Phytoextraction (P-X)) candidate

Indigenous plant species	Bio-concentration (BCF) and Translocation factor (TF)		P-S/P-X Behavior of plant	References
Sida cardifolia and Chenopodium album	(i)	[BCF<1,TF<1] for Co	P-S	Gupta and Sinha, 2008
	(ii)	[BCF>1,TF <1] for Ni and Pb	P-S	
	(iii)	[BCF>1,TF>1] for Cd, Cr, Cu, Fe, Zn	P-X	
Cassia siamea	(i)	[BCF>1,TF>1] for Pb, Zn, Cu, Ni, Cr	P-X	Jambhulkar and Juwarkar 2009
Ricinus communis	(i)	[BCF<1,TF<1] for Cd, Cu, Ni, Pb, and Zn	P-S	Pandey et al., 2013a
Saccharum munja	(i)	[BCF<1,TF<1] for Cd, Cr, Cu, Ni, Pb, Zn.	P-S	Pandey et al. 2012
	(ii)	[BCF<1,TF>1] for Mn and Fe	P-X	
Ipomea carnea	(i)	[BCF<1,TF<1] for Cu	P-S	Pandey et al., 2013
	(ii)	[BCF>1,TF<1] for Ni, Pb	P-S	
	(iii)	[BCF<1,TF>1] for Cr	P-S	
	(iv)	[BCF>1,TF>1] for Cd	P-X	
Thelypterys dentate	(i)	[BCF<1,TF<1] for Fe, Si]	P-S	Kumari et al., 2013
	(ii)	[BCF>1,TF<1] for As, Cd, Pb	P-S	
Typha latifolia	(i)	[BCF <1,TF<1] for Cd	P-S	Pandey et al., 2014
	(ii)	[BCF<1,TF>1] for Cr, Cu, Ni, Pb, and Zn	P-X	
	(iii)	[BCF>1,TF>1] for Mn	P-X	
Cynodon dactylon and Saccharum munja	(i)	[BCF<1,TF<1] for Fe and Ni	P-S	Kumar et al., 2015
	(ii)	[BCF>1,TF<1] for Pb	P-S	
	(iii)	[BCF<1,TF>1] for Cd, Cu, and Mn	P-X	
Festuca rubra	(i)	[BCF<1,TF<1] for As, Cu, Mn, and Zn	P-S	Gajic et al., 2016
	(ii)	[BCF<1,TF>1] for B in leaves	P-X	

Saccharum munja, S. ngrum, P. hysterophorus, I. carnea and T.	(i) (ii)	[BCF<1,TF<1] for Cd, Cr,Ni, and Pb [BCF>1,TF>1] for Mn, Zn and Fe	P-S P-X	Kisku et al., 2018
Typha latifolia and Saccharum spontaenum	(i) (ii)	[BCF<1,TF<1] for Pb, Zn, and Cu [BCF>1,TF>1] for Mn	P-S P-X	Maiti and Jaiswal, 2008
Cassia tora and Sida acuta Burm. f.	(i)	[BCF>1,TF>1] for Zn,Fe,Cr,Mn and Cu	P-X	Panda et al., 2020a
Castor (Ricinus comunis L.)	(i)	[BCF>1] for Cr, Cu, Al, Fe, Zn and Mn	P-X	Panda et al., 2020b
N. glauca	(i)	[BCF>1,TF>1] for Pb and Cu	P-X	Gajaje et al., 2021
P.burchelii	(i) (ii)	[BCF<1,TF>1] for Pb [BCF>1,TF>1] for Zn	P-X	Gajaje et al., 2021
I. *pest- tigridis*	(i)	[BCF>1,TF>1] for Zn and Pb	P-X	Gajaje et al., 2021
E. hirta	(i)	[BCF>1,TF>1] for Zn	P-X	Gajaje et al., 2021
A.*spinosus*	(i)	[BCF>1,TF>1] for Pb	P-X	Gajaje et al., 2021
A.pungens	(i)	[BCF>1,TF>1] for Cr,Cu, and Zn	P-X	
C.dactylon	(i)	[BCF>1,TF>1]for Cu and Zn	P-X	Gajaje et al., 2021
D.aegyptium	(i)	[BCF>1,TF>1] for Pb	P-X	Gajaje et al., 2021

TABLE 2 Mechanism of Metal transport system in the plant

Metals	Cell site/plant part	Transport system	Reference
Arsenic (V)	All cell	As—Pi transport system	Verbruggen et al., 2009
Arsenic (III)	All cell	NIP Family-aquaporin proteins	Verbruggen et al., 2009
Arsenic	Xylem	Silicon transporter (Lsi2)	Ma et al., 2008
Arsenic	Vacuole (As-GSH complex and Phytochelatin complex As-PCs)	ABC transporter	Tripathi, 2007
Copper	Vacuole	IP2, ZIP4, COPT1,COPT3, COPT5	Migocka and Malas, 2018
	Chloroplast, mitochondria and Golgi complex	HM—ATPases and chaperones	
	Xylem	HMA7/RAN1	
Low-Mn	Leaves	ZIP3-ZIP7, NRAMP1 and OsNRAMP5; NRAMP3/NRAMP4 proteins transport	Lanquar et al., 2010; Sasaki et al., 2012
Mn	Intracellular transport and accumulation	P-type ATPase	
	Golgi complex	PMR1	
	vacuole homeostasis,	ABC transporters, Mitochondrial family protein Metal/H+ antiporter (CAX2), CDF family of transporters	Wu et al., 2002; Shigaki et al.,2003.
High-Mn	root	ZRT/IRT1 transporters	Pedas et al., 2005
Zn-Homeostasis	Plant cell	MAs (mugenic acids) and nicotinamine (NA) mediate trasnport	Sinclair and Kramer, 2012
Low-Zn	Zn from soil→ root →leaf	ZRT—IRT transporters ZIP 1, 3 9–12 take up Zn from the	Bashir et al., 2012

		soil; IRT3, ZIP4, 5, 8	
	Apoplast and xylem	P—type ATPases	
	Plastids and vacuole	HMA2 and HMA4	Wong and Cobbett, 2009
High-Zn	Zn in chloroplast	HMA1 transporter contributes to the detoxification	Kim et al., 2009
	vacuole of leaves and roots	MTP1, 2, 3 transporters CDF family transporters ZIF1 protein	Haydon et al., 2012
Fe	Dicotyledonous plant $Fe3+ \rightarrow Fe2+$	FRO and 3 FRO transporters	Mukherjee et al., 2006
	Graminaceous plants $Fe3+ \rightarrow$ Fe3+MA complex	MAs; efflux transporter TOM1) YELLOW STRIPE 1 (YS1) and YELLOW STRIPE 1–like (YSL) transporters	Inoue et al., 2009; Nozoye et al., 2011
	Roots	IRT1 transporter	Hall and Williams, 2003
Pb, Cr and Cd	Plant part	ZIP/IRT, IRT1, IRT2, HMA9 ABC transporters	Hall and Williams,2003; Bovet et al., 2003; Clemens, 2006;
Cd	vacuole of the root	Cd2+/H+ and CAX2 antiporters MATE	Hirshi et al.,2000
Ni	Root and Leaves	MGT1 trasporter	Li et al., 2001

TABLE 3 Sustainable amendments for suitable FA utilization in land for economic crops growth.

Sustainable amendment combination	Economic crop	Remarks	references
FA + fertile garden soil + 0.3 g kg^{-1}+ EDTA at 0.1 g kg-1	Jatropha curcas	Potential accumulation of heavy metals Fe, Al, Cr, Cu and Mn	Jamil et al., 2009
FA+poultry bio-solid	*Panicum amarum*, *Lespedeza cuneata*, and *Eragrostis curvula*	Nutrient status of soil improve	Punshon et al., 2002
FA+compost+press mud+Formyard mannure	Paddy crop	Methanotrophic population, yield, and plant antioxidant activity, Soil health	Singh and Pandey 2012.
FA (40t ha^{-1})+K-fertilizer (60kgha^{-1})	Mustard	Phytostabilization for Cr,Cd and Pb, Rise antioxidant activity	Ashfaque and Inam, 2019
T1 [Fly-ash+press-mud (1:1, w/w)] T2 [Fly ash+ cow dung manure + garden soil (1:1:1)]	Cassia siamea Lamk	T1 revealed that Rise in biomass, leaf number, photosynthetic area, total chlorophyll and protein) was significantly high in this treatment amount of Cu, Zn, Ni and and Fe followed by T2	Tripathi et al., 2004
FA+ Mychorrhiza+NPK fertilizer	*Cymbopogon citratus*	High yield and sow more phyto-stabilization potential against	Ultra, 2020

		heavy metal	
Pellet FA (PA)+Coal FA+ Paper waste	*Brassica comestris*	FA pillet rise growth and yield	Jayasinghe and Tokashiki, 2012
FA+Sewage sludge+lime (60:30:10)	Corn, Potato, Beans (Pot experiment)	Rise in soil phosphorous,Ca, Mg and reduced translocation of nickel and cadimum	Reynolds et al., 1999
FA+Cow dung+epigenic earthworm	Rise phosphate solubilization bactera	Nutrient avavibility, Rise soil respiration	Bhattacharya and chattopadhyay, 2002; Pati and Sahu, 2003
FA+, BGA + NF	Rice	Improve growth, yield and mineral content	Tripathi et al., 2008
FA (40 to 60%)+Wheat straw+2 rock phosphate	Supports microbial population	And maintain C;N ration in soil	Gaind and Gaur,2003
FA+ Organic amendments+ blue-green algal+ Rhizobium	*Prosopis juliflora* L.,	Incudes potential of P-S and P-X in plant.	Rai et al., 2004
FA (40t/ha) +Pseudomonas stritia	Soybean	No adverse effect on Pseudomonas stritia poplation	Gaind and Gaur,2002
FA (40%)	Sun flower (Helianthus annus)	Fe, Pb,Mn,and Zn were bellow the permissible limit	Siddiqui et al., 2004
FA (40%)+Mannure	Chickpea	Rise yield and shows rizofiltration for heavy metal	Upadhyay et al., 2021