Application of Human Urine – Productivity and Impacts

-- Rahul Bakare

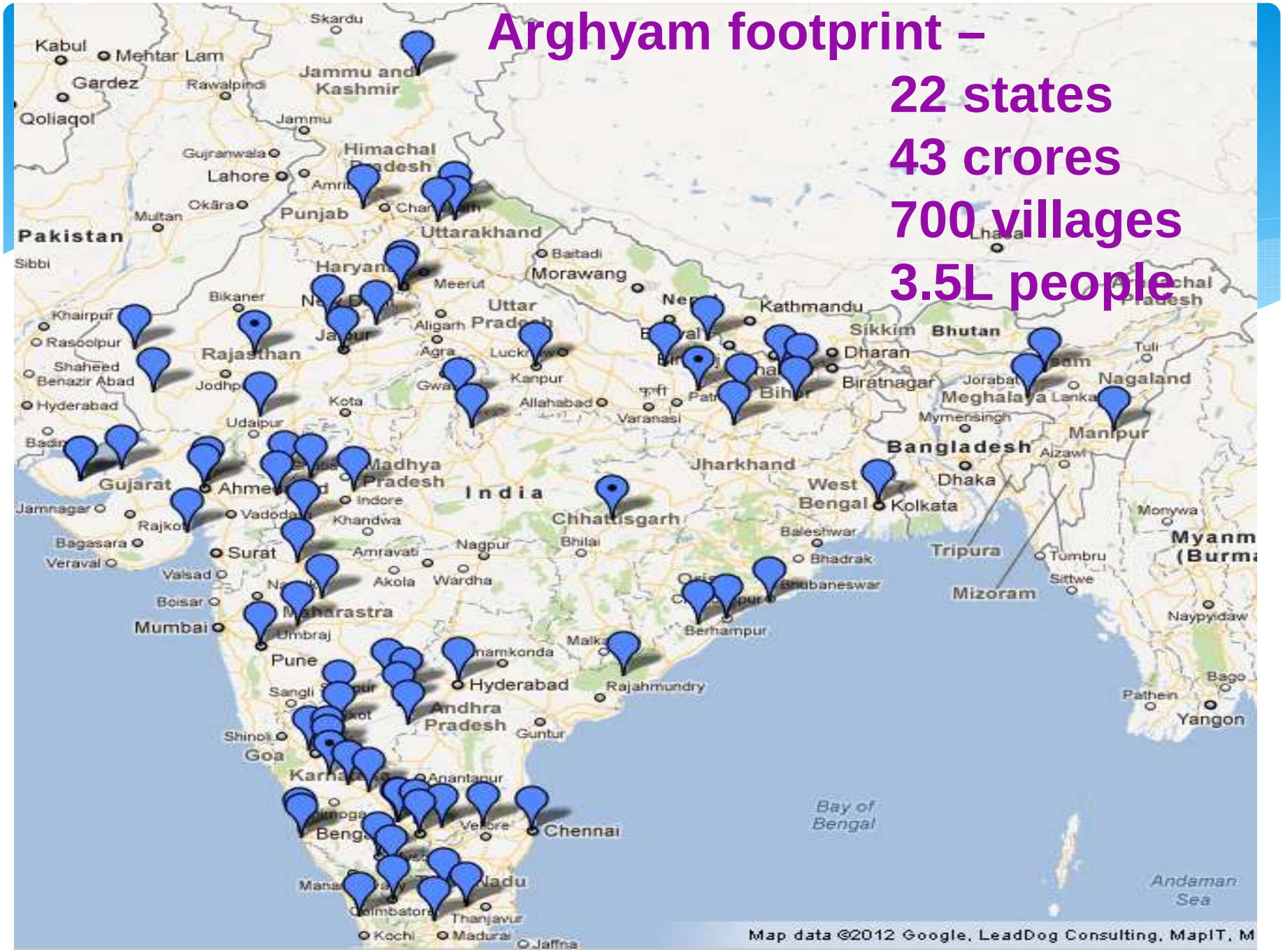
Arghyam

Arghyam – "*Offering*"

- Registered as a Public Charitable Trust in 2001
- Personal endowment from Rohini Nilekani
- Primarily supports the Water sector

Vision : Safe, sustainable water for all

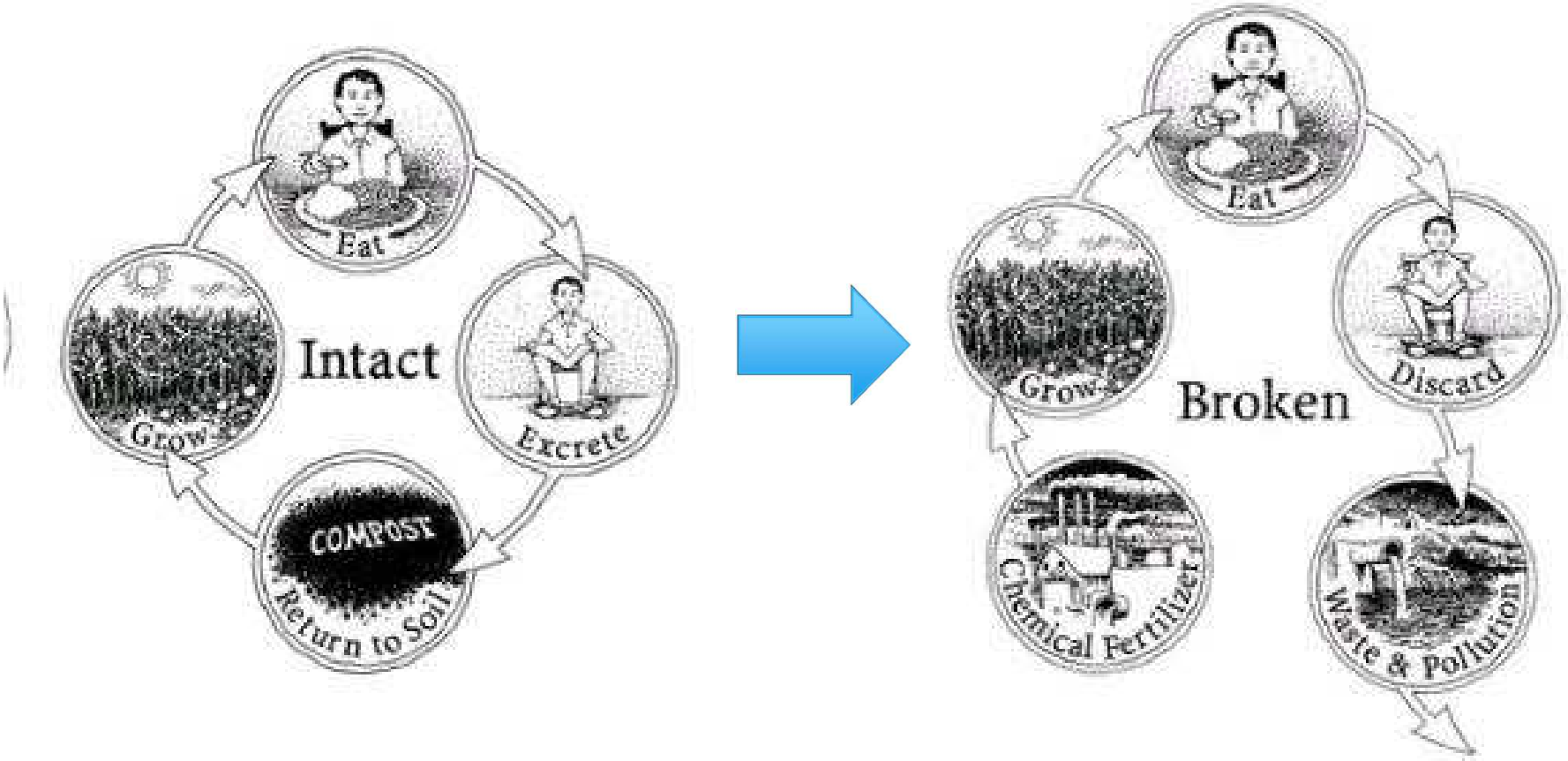
Mission: To support Sustainable efforts that enhance Equity in access to Water for all


Arghyam footprint –
22 states
43 crores
700 villages
3.5L people
Skardu
Kabul
Mehtar Lam
Gardez
Rawalpindi
Jammu and Kashmir
Qoliaqol
Jammu
Gujranwala
Himachal Pradesh
Lahore
Amritsar
Okara
Punjab
Multan
Pakistan
Uttarakhand
Sibbi
Haryana
Batadi
Morawang
Meerut
Bikaner
Uttar Pradesh
Aligarh
Kathmandu
Khairpur
Rasoolpur
Jaipur
Agra
Sikkim
Bhutan
Rajasthan
Lucknow
Kanpur
Dharan
Shaheed Benazir Abad
Jodhpur
Allahabad
Biratnagar
Nagaland
Hyderabad
Kota
Varanasi
Meghalaya
Udaipur
Mymensingh
Manipur
Bangladesh
Madhya Pradesh
Jharkhand
Gujarat
India
Dhaka
West Bengal
Kolkata
Ahmedabad
Indore
Chhattisgarh
Jamnagar
Vadodara
Khandwa
Rajkot
Balasore
Bhadrak
Bhilai
Nagpur
Surat
Amravati
Tripura
Veraval
Akola
Wardha
Bhubaneswar
Valsad
Mizoram
Sittwe
Boisar
Maharastra
Berhampur
Mumbai
Umbraj
Malkangiri
Pune
Hyderabad
Rajahmundry
Sangli
Andhra Pradesh
Guntur
Shimoga
Goa
Anantapur
Bay of Bengal
Vellore
Chennai
Andaman Sea
Coimbatore
Thanjavur
Kochi
Madurai
Jaffna
Yangon
Pathein
Bago
Naypyidaw
Map data ©2012 Google, LeadDog Consulting, MapIT, M

Key activities

* India Water Portal
  * 4 Portals (English, Hindi, Kannada, Sanitation)
  * First such effort in country
* Integrated Urban Water Management
  * Social, technical, scientific studies, framework, institutional model dev.
* ASHWAS
  * Rural water and sanitation in Karnataka. 28 districts, 17200 households

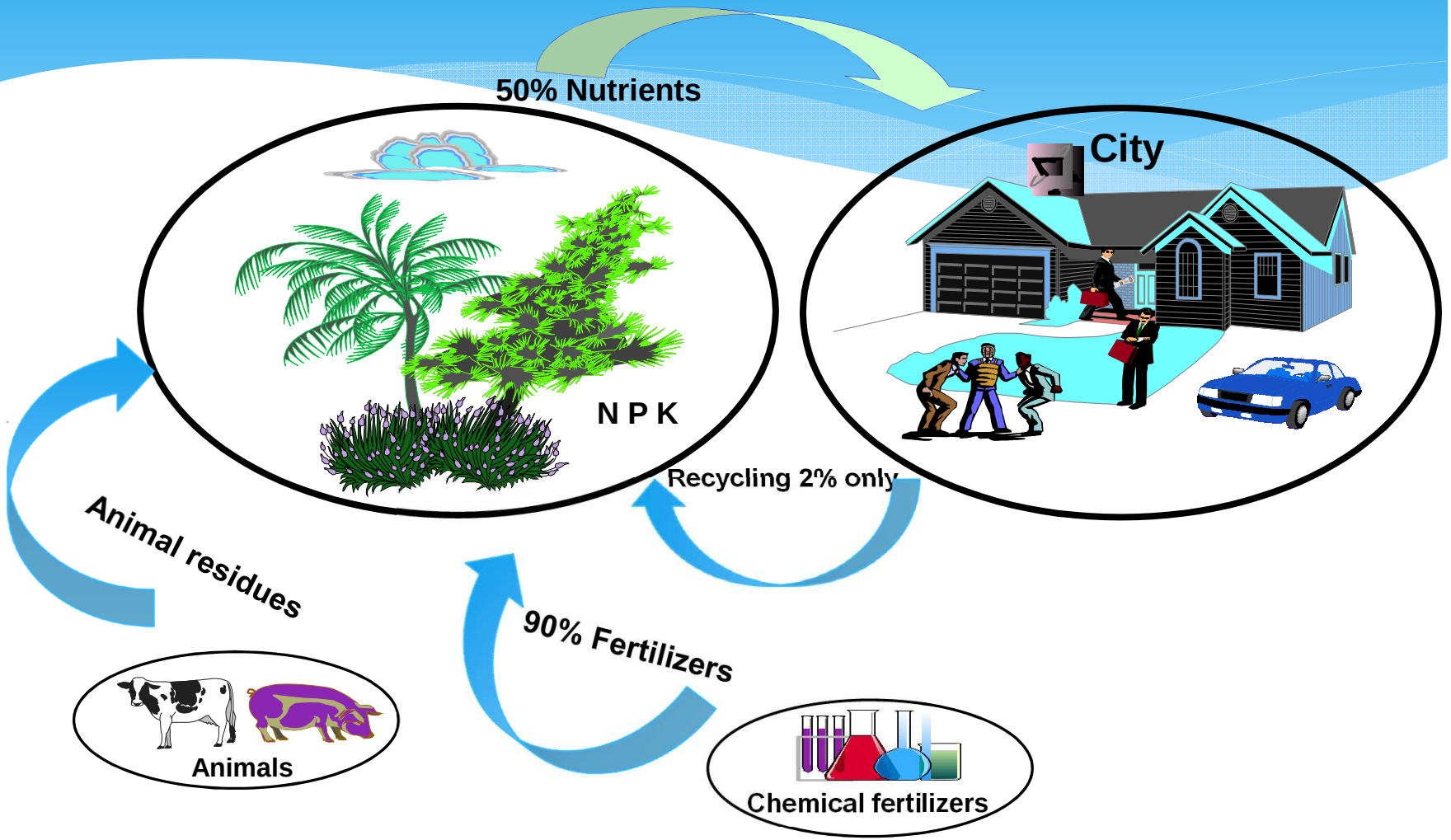
Human Nutrient Cycle



Compounded by - Urbanization

Compounded by – Mixing of Water and Nutrients

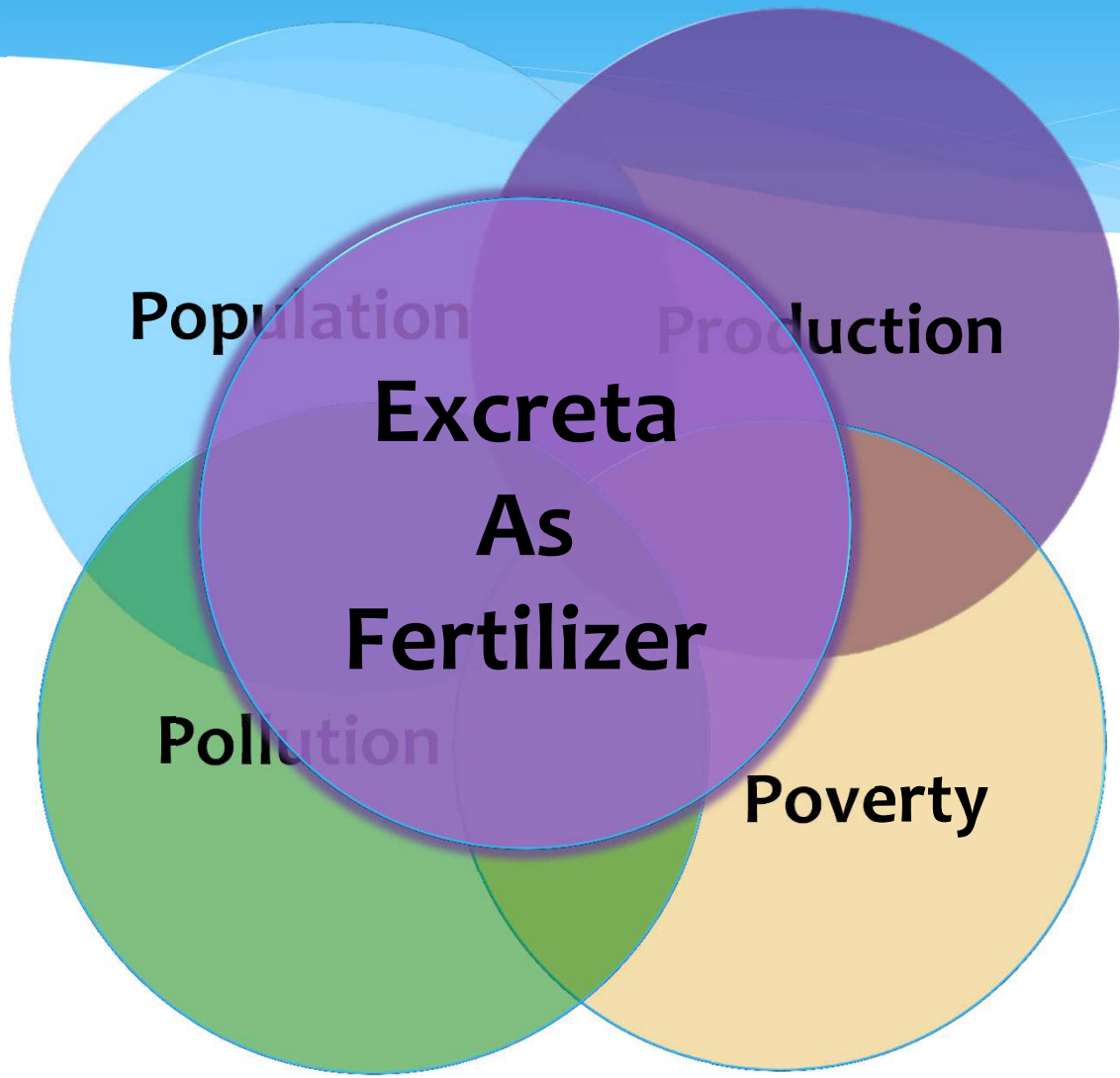
PLANT NUTRIENTS PILING UP IN URBAN AREAS
(UN SCIENTIFIC & NEGILIGANT RECYCLING)



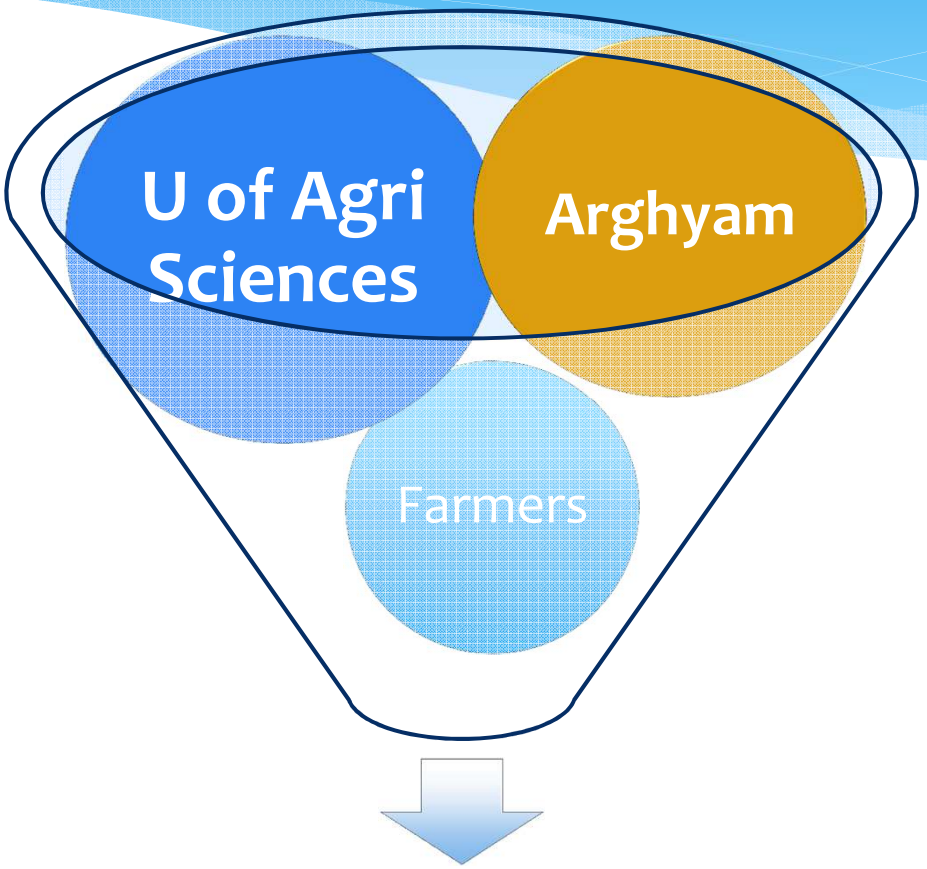
Problems

* Growing demand for fertilizers
* Shortage and escalating cost of fertilizers
* Nutrient deficiencies in soils
* Declined yield of crops
* Decreased availability of good quality water

Excreta as Fertilizer



Research Study

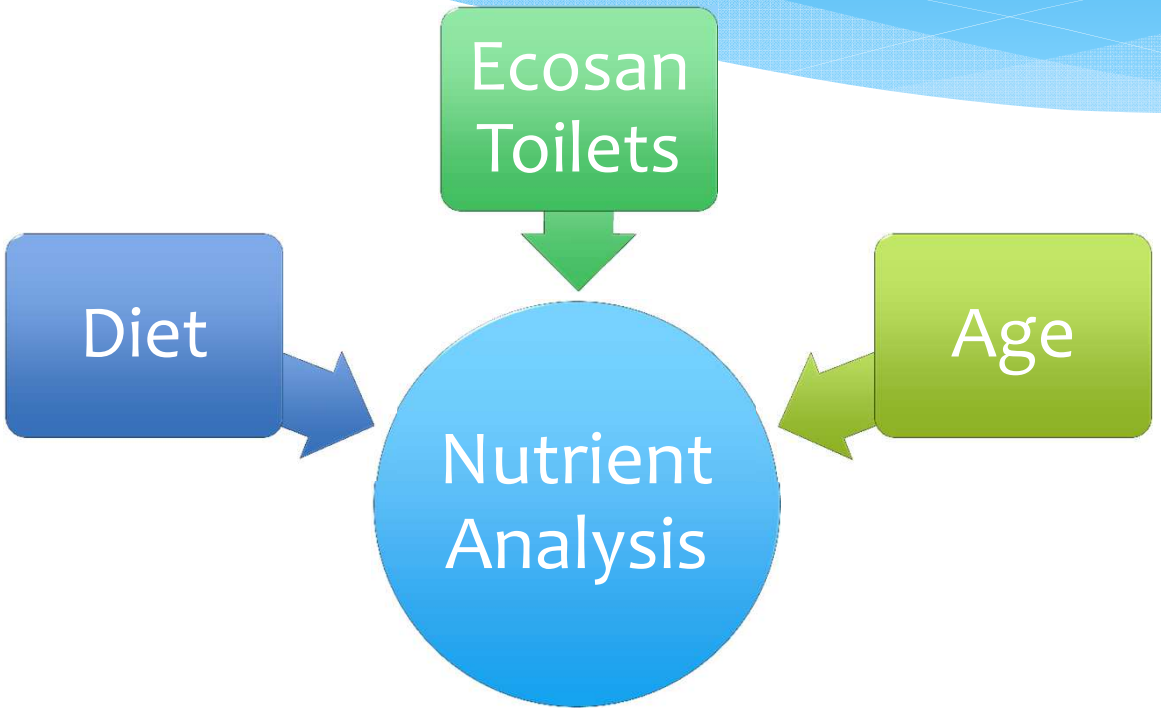


Application of Liquid Waste Research

Objectives

* Characterization of human urine for its nutrients potential
* Agronomic evaluation of anthropogenic wastes for crop production and its impact on yield and quality of crops
* To study the short and long-term impact of anthropogenic wastes on soil properties
* To work out cost economics of use of anthropogenic wastes for crop production

Characterization of human urine for nutrients composition



2009- French bean, Bhendi, Tomato, Brinjal, Field bean & Finger millet

2010- Aerobic rice, finger millet, maize, cow pea, soybean and field bean

2011- Cluster bean and marigold

Farmers' Field trials

* Location- Nagasandra,
* No. of experiments: 1 (4 crops)
* Crops – Ash gourd, French bean, pole bean and pumpkin
* Treatments : 14
* Treatment details : FYM alone, RDF, Human urine, Cow urine in single and split dose with and without gypsum

Nutrient composition of human urine, cattle urine & FYM used in experiments

Sources	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Human Urine	0.30	0.16	0.17
Cattle urine	0.25	0.09	0.11

Table 4: Effect of human urine (HU), cow urine (CU) and FYM+ human urine on yield of crops during 2009.

Crop	RDF (Kg ha^{-1})	Quantity of human urine/cow urine required to supply recommended dose of nitrogen					
		HU (l ha^{-1})	CU (l ha^{-1})			CU	FYM+HU
French beans	63:100:75	33333	50000	1.1	3.99	2.41	4.87
Field bean	25:50:25	8333	12500	1.73	4.61	4.04	4.61
Tomato	250:250:250	83333	125000	16.6	28.3	27.6	29.6
Brinjal	125:100:50	41667	62500	9.2	32.5	29.8	33.6
Bhendi	125:750:63	41667	62500	7.0	13.2	12.3	13.7
Grain yield (t ha^{-1})							
Finger millet	100:50:50	33333	50000	2.11	3.78	3.22	6.17

100-200% Improved Productivity

French bean grown using Chemical fertilizers

French bean grown using Human urine

Table 5: Effect of human urine, cow urine and FYM+ human urine on yield of crops during 2010 and 2011.

100-200% Improved Productivity

Crop	RDF (Kgha^{-1})	Quantity of human urine/cow urine applied to supply recommended dose of nitrogen		Yield (t ha^{-1})				
		Human urine (l ha^{-1})	Cattle urine (l ha^{-1})	Control	RDF	Human urine	Cattle urine	FYM + HU
2010								
Aerobic rice	**100:50:50**	33,333	50,000	**1.12**	2.58	2.63	1.92	**2.74**
Finger millet	**100:50:50**	13,333	20,000	**1.47**	2.54	3.22	2.59	**3.31**
Maize	**150:75:40**	50,000	75,000	**3.89**	6.69	6.82	6.55	**6.89**
Cow pea	**25:50:75**	8,333	12500	**0.74**	1.00	1.02	0.98	**1.03**
Soybean	**30:80:38**	10,000	15,000	**0.56**	1.23	1.25	1.16	**1.52**
Field bean	**25:50:25**	8,333	12,500	**0.63**	1.21	1.42	1.25	**1.44**
2011								
Cluster bean*	**25:75:60**	8,333	12,500	**5.64**	6.65	6.74	6.54	**6.88**
Marigold **	**225:60:60**	75,000	1,12,500	**5.67**	6.68	6.67	6.35	**6.70**

* Fresh vegetable yield
** Flower yield

Impact of Urine Application on Soil

Treatments	pH (1:2.5)	EC dSm^{-1}	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
French bean					
Control	6.03	0.14	236.5	27.3	226.1
CU	6.12	0.48	423.6	56.7	390.4
HU	5.73	0.40	473.6	61.2	436.5
FYM+HU	6.15	0.16	597.9	61.3	448.1
SEm ±	0.16	0.12	17.36	2.47	14.1
CD(P=0.05)	0.49	0.35	52.04	7.41	42.31
Field bean					
Control	5.60	0.17	289.8	28.7	239.0
CU	6.43	0.21	423.6	56.7	390.4
HU	6.26	0.32	473.6	61.2	436.5
FYM+HU	6.43	0.25	597.9	61.3	448.1
SEm ±	0.14	0.05	14.02	0.19	11.54
CD(P=0.05)	0.42	0.16	42.08	0.58	34.69
Tomato					
Control	5.89	0.94	258.9	21.8	204.0
CU	6.00	1.25	368.6	46.7	276.4
HU	6.21	1.35	398.6	63.6	342.2
FYM+HU	6.54	1.12	403.5	67.8	356.9
SEm ±	0.14	0.05	0.42	5.03	0.69
CD(P=0.05)	0.42	0.16	1.25	15.08	2.28

Treatments	pH (1:2.5)	EC dSm^{-1}	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
Brinjal					
Control	5.91	0.97	258.5	26.9	199.6
CU	6.10	1.25	368.0	33.5	270.5
HU	6.33	1.30	397.9	41.2	334.8
FYM+HU	6.34	1.16	402.8	49.5	349.2
SEm ±	0.15	0.06	0.39	0.27	0.67
CD(P=0.05)	0.44	0.18	1.16	0.82	2.00
Bhendi					
Control	5.98	0.93	253.9	22.1	200.0
CU	6.08	1.20	361.4	47.2	271.0
HU	6.40	1.25	390.7	64.2	335.5
FYM+HU	6.64	1.18	395.6	68.5	349.9
SEm ±	0.15	0.06	0.41	5.08	0.68
CD(P=0.05)	0.46	0.17	1.23	15.23	2.24
Finger millet					
Control	6.70	0.15	233.1	27.8	246.4
CU	6.31	0.20	398.6	34.6	436.7
HU	6.38	0.29	415.3	33.9	488.1
FYM+HU	7.02	0.19	520.6	56.4	616.4
SEm ±	0.05	0.15	16.12	3.27	17.36
CD(P=0.05)	0.16	0.46	48.36	9.82	52.04

Table 7: Effect of human urine, cattle urine FYM+HU on pH, EC (dSm^{-1}) available nitrogen, phosphorus and potassium content of soil (kg/ha) at harvest stage of crops during 2010.

Treatments	pH (1:2.5)	EC dSm^{-1}	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
Aerobic rice					
Control	6.72	0.15	233.1	27.8	247.8
CU	6.35	0.20	400.1	34.6	446.3
HU	6.40	0.29	420.0	54.2	481.7
FYM+HU	7.06	0.19	500.1	56.0	485.0
SEm ±	0.06	0.05	1.30	0.31	0.90
CD(P=0.05)	0.18	0.15	3.93	0.94	2.80
Finger millet					
Control	5.77	0.17	294.3	29.3	247.4
CU	6.62	0.21	423.4	57.8	400.9
HU	6.45	0.33	467.9	62.1	448.2
FYM+HU	6.62	0.24	498.4	62.4	460.1
SEm ±	0.01	0.02	2.63	0.89	1.17
CD(P=0.05)	0.04	0.06	7.92	2.68	3.54
Maize					
Control	6.05	0.09	241.4	27.5	227.8
CU	6.12	0.17	422.3	34.2	405.3
HU	6.18	0.39	472.1	53.0	410.4
FYM+HU	6.25	0.13	502.6	55.7	506.3
SEm ±	0.14	0.10	1.48	0.57	1.44
CD(P=0.05)	0.47	0.35	4.45	1.17	4.33

.....Contd.

Treatments	pH (1:2.5)	EC dSm^{-1}	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
Cowpea					
Control	5.92	0.95	265.0	24.0	210.3
CU	6.03	1.26	377.3	47.8	282.9
HU	6.28	1.36	407.9	65.1	350.2
FYM+HU	6.58	1.13	412.9	69.4	365.3
SEm ±	0.01	0.01	1.48	1.41	1.43
CD(P=0.05)	0.04	0.03	4.43	4.30	4.28
Soybean					
Control	5.98	0.98	262.8	27.3	202.9
CU	6.13	1.27	374.2	34.1	275.0
HU	6.38	1.32	404.6	41.9	306.0
FYM+HU	6.73	1.17	409.6	50.0	306.0
SEm ±	0.16	0.07	1.40	0.08	0.09
CD(P=0.05)	0.47	0.20	1.88	0.28	1.30
Field bean					
Control	6.09	0.94	254.7	22.4	208.1
CU	6.19	1.21	362.9	48.0	281.5
HU	6.44	1.26	392.5	65.1	331.5
FYM+HU	6.69	1.20	396.0	69.6	362.5
SEm ±	0.03	0.01	0.04	0.20	1.30
CD(P=0.05)	0.06	0.03	1.20	0.50	4.20

Table 8: Effect of human urine, cattle urine, FYM+HU on nutrient content of soil at harvest stage of crops during 2011.

Treatments	pH (1:2.5)	EC dSm^{-1}	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
Cluster bean					
Control	**6.84**	**0.16**	**230.77**	**27.44**	**346.79**
CU	6.80	0.20	396.10	34.15	446.29
HU	6.85	0.32	415.80	53.46	481.69
FYM+HU	**7.14**	**0.24**	**495.10**	**55.30**	**484.99**
SEm ±	0.12	0.01	1.09	0.22	0.30
CD(P=0.05)	0.40	0.04	3.19	0.45	1.85
Marigold					
Control	5.77	0.17	292.47	29.14	440.88
CU	**6.62**	**0.21**	**420.87**	**57.67**	**457.17**
HU	**6.45**	**0.33**	**464.95**	**61.66**	**397.34**
FYM+HU	6.62	0.25	497.97	62.00	401.58
SEm ±	0.01	0.02	2.56	0.46	1.06
CD(P=0.05)	0.04	0.06	7.92	1.38	3.18

Cost economics

Crop	RDF (kg/ha)	Quantity of human urine required (L/ha)	Yield (t/ha)	Fertilizer cost (Rs.)	Human urine cost (Rs.)	Savings towards fertilizers (Rs./ha)
Aerobic rice	100:50:50	33,333	2.63	5148	1667	3481
Maize	150:75:40	50,000	6.82	6728	2500	4228
Soybean	30:80:38	10,000	1.25	5441	500	4941
Field bean	25:50:25	8,333	1.42	3513	415	3096

Note: Urea 5.6: SSP: 8.0 & MOP:17.0 (Rs./kg) **Source: FCI, 2012**

Transportation cost for Human urine Rs.5 paise/liter

Research Conclusion

* Increase in production by more than 100% in Green House and Farm Trials
* “Farm Yard Manure + Human Urine” provides the maximum outputs
* Positive Impact of Application of Human Urine on soil
* Unlike Chemical Fertilizers Human Urine Application is beneficial for the quality of soil
* Cost Savings

Future Problems

India Sanitation (Census 2011)

Septic Tanks

	(million)
* Urban	30.09
* Rural	24.67
* **Total**	**54.76**

Pit toilets

	(million)
* Urban	55.97
* Rural	17.68
* **Total**	**73 .65**

Grand Total 128.41

Septic tanks and Pit Latrines

Another 113 million rural households and 14 million urban households will build toilets and mostly pit toilets in the near future

This represents a **MASSIVE**

sludge management challenge

Peri-urban areas out of UGD

Mobile Technology

Cost of Emptying = Rs 800 – 3000… Informal Economy

We estimate nearly 300 honey-suckers in Bangalore

Protocol for safe disposal needs to be evolved

The sewage is nutrient rich but also pathogenic

Soil as a nutrient recipient rather than water

Future Research

* Field Trials of ALW experiments in two farmers fields
* Transfer of Knowledge of Jeevamrutha and Panchagavya using Humanure to Farmer community
* Developing protocol on use of composted humanure from Honeysuckers
* Analysis of Humanure for
  - for nutrient composition
  - handling and composting
  - field experiments of humanure
  - Effect on soil properties yield and quality of crops

Excreta Matters
and
Matters a lot for
the
Sustainability of Mankind

Thank You

-- rahul@arghyam.org