Agriculture use of Filter cake

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Understanding soil in Pakistan

1. Low organic matter & burning of crop residue
2. High pH
3. Low CEC
4. Depleting P, K, Mg & S bank
5. Poor biological health

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Analysis Background

- Number of Sample Analyzed -> 729974
- Number of variable Analyzed -> 3
- Data Anomalies and outlies -> 0

Color Code

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Parameter for Analysis

Nutrient	Critical	Weak	Average	Moderate	Healthy
OM	<0.5	>0.5<.75	>0.75<1	>=1<=1.25	>1.25
P2O	<5	>=5<10	>=10<15	>=15<=20	>20
K2O	<50	>=50<100	>=100<150	>=150>=200	>200

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Result for Analysis

Nutrient	Critical	Weak	Average	Moderate	Healthy
OM	201121	352104	158920	15696	2133
P2O	194477	468316	51424	12127	3630
K2O	12572	120255	396263	165329	35555

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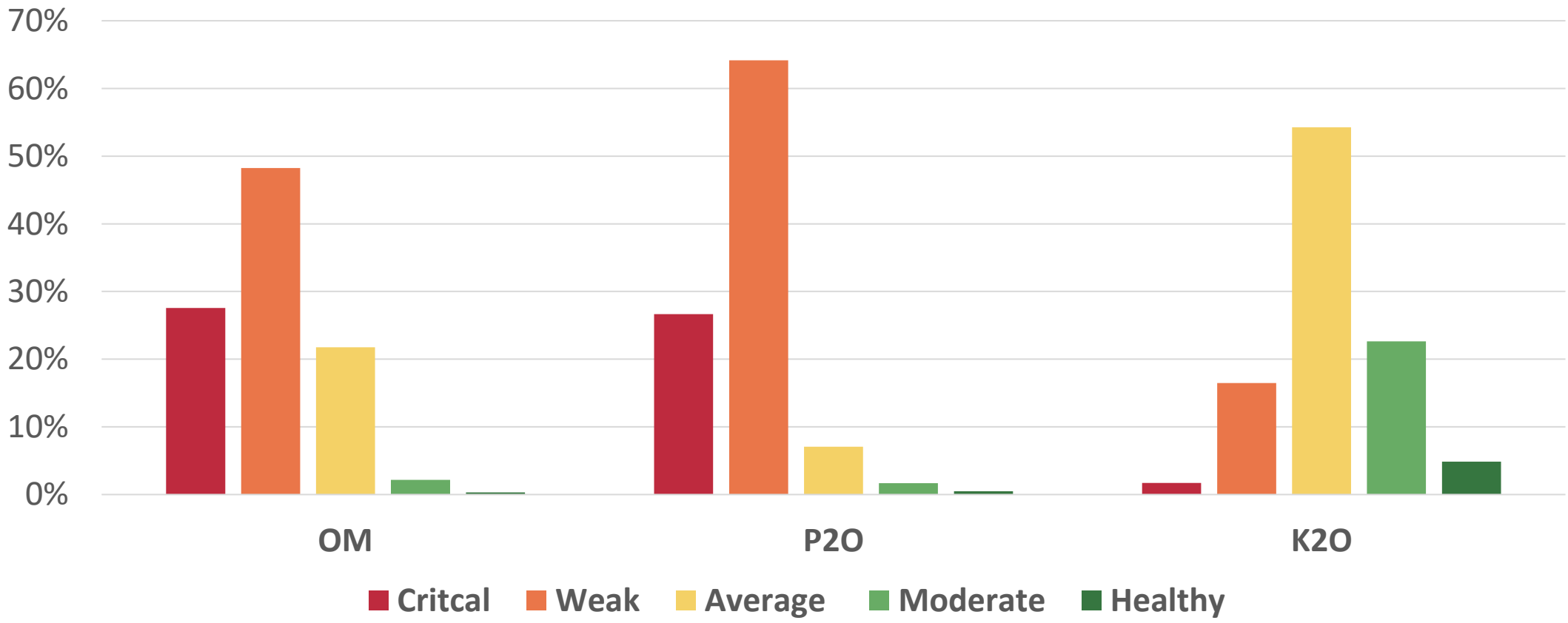
Data Summery Report



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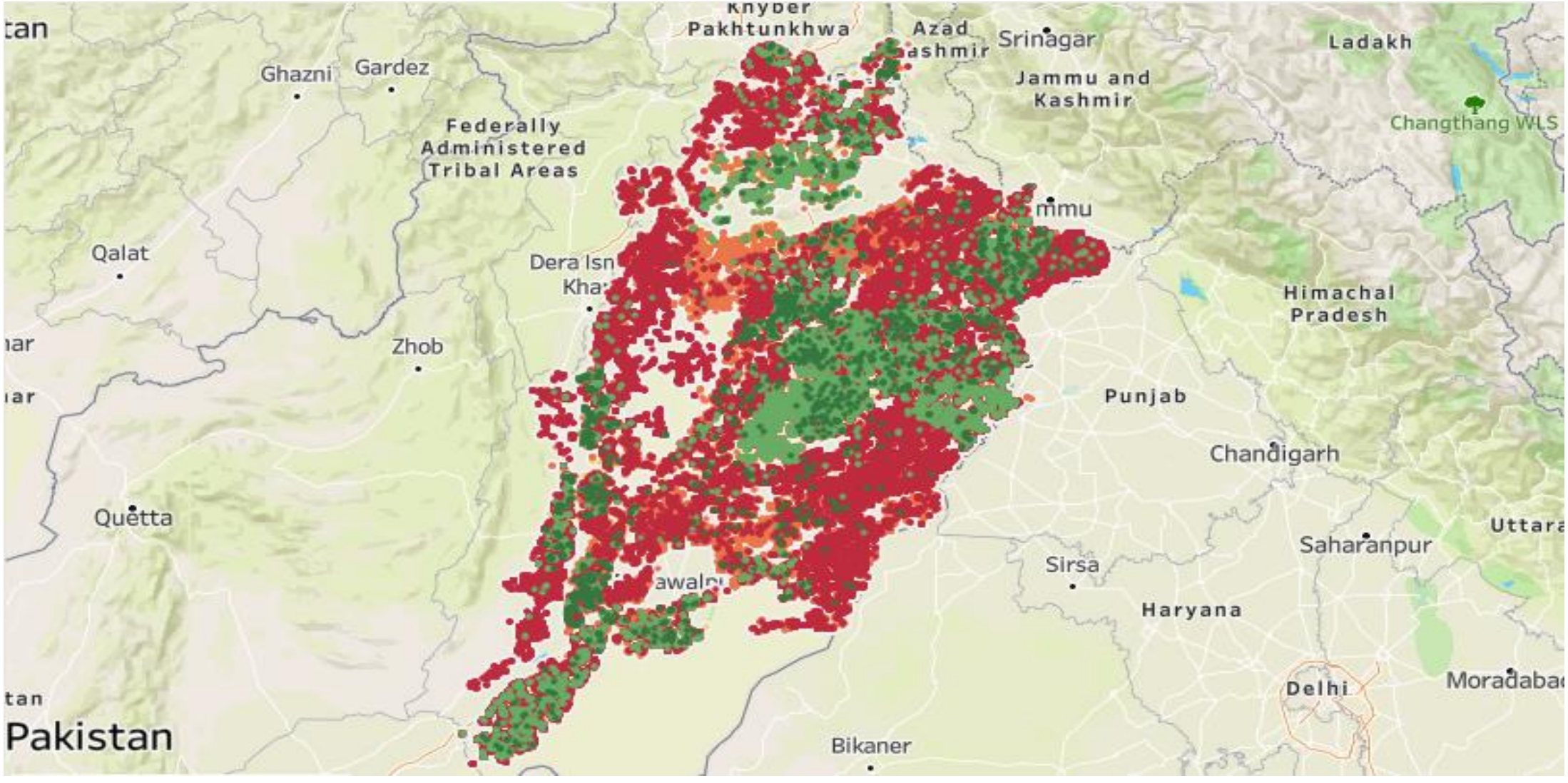
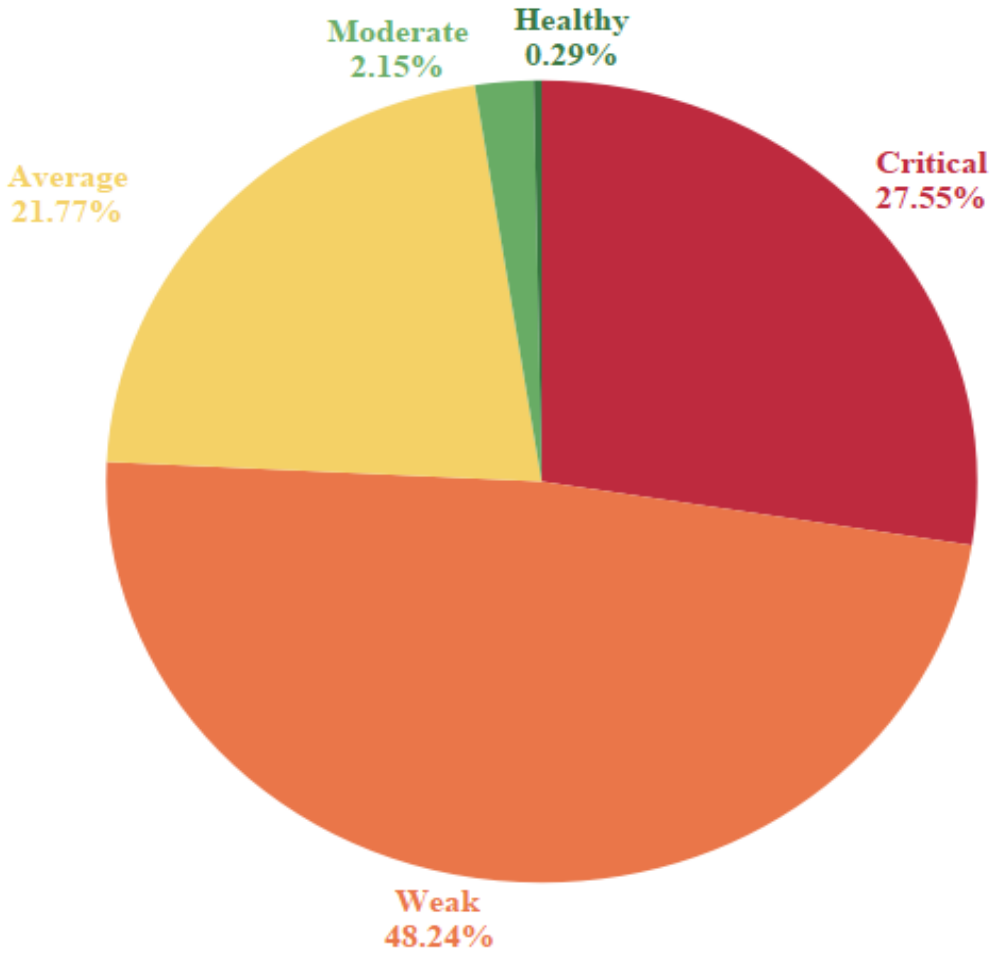
Soil map of Punjab – Organic matter



Soil map of Punjab – Organic matter



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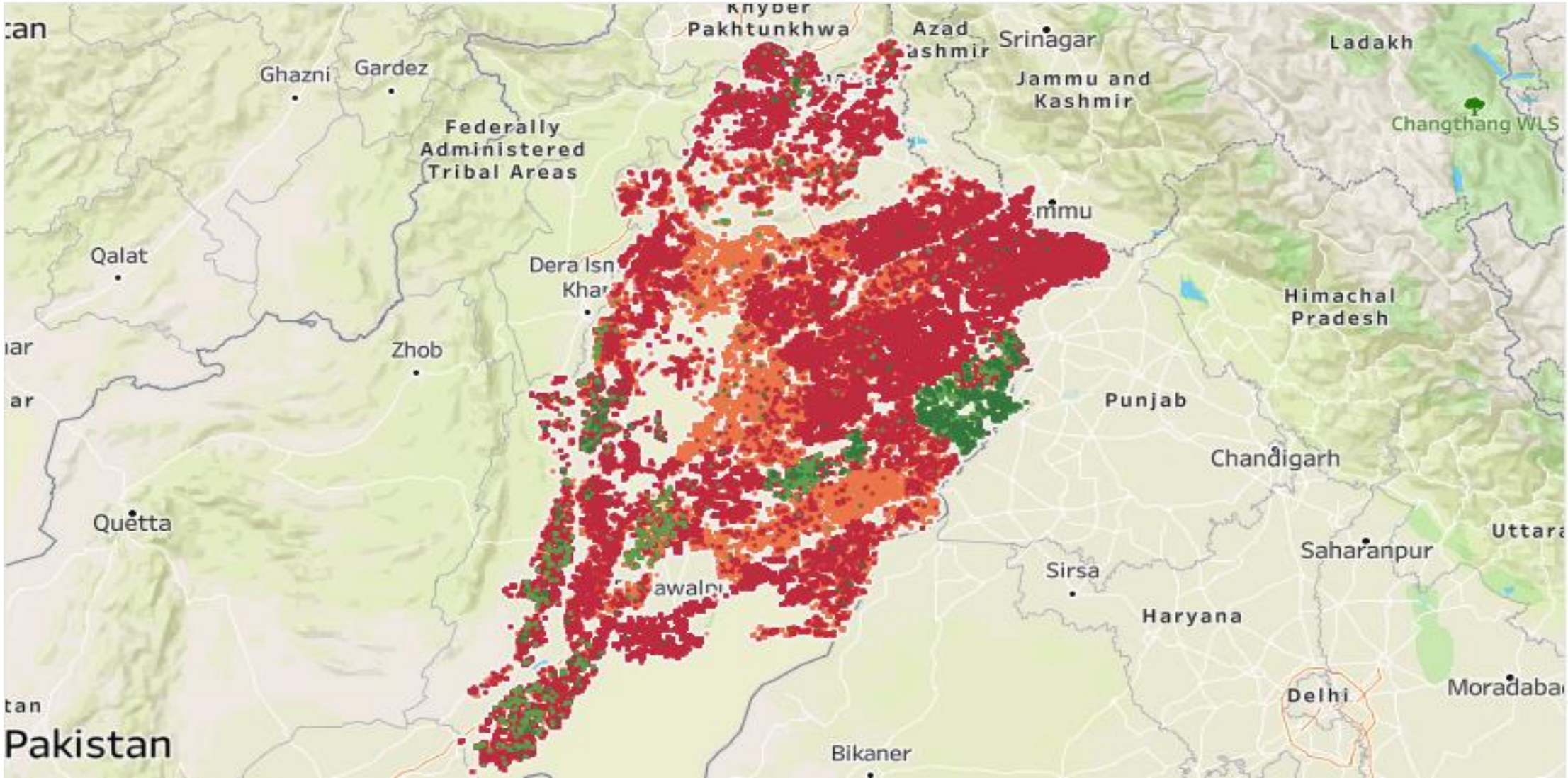
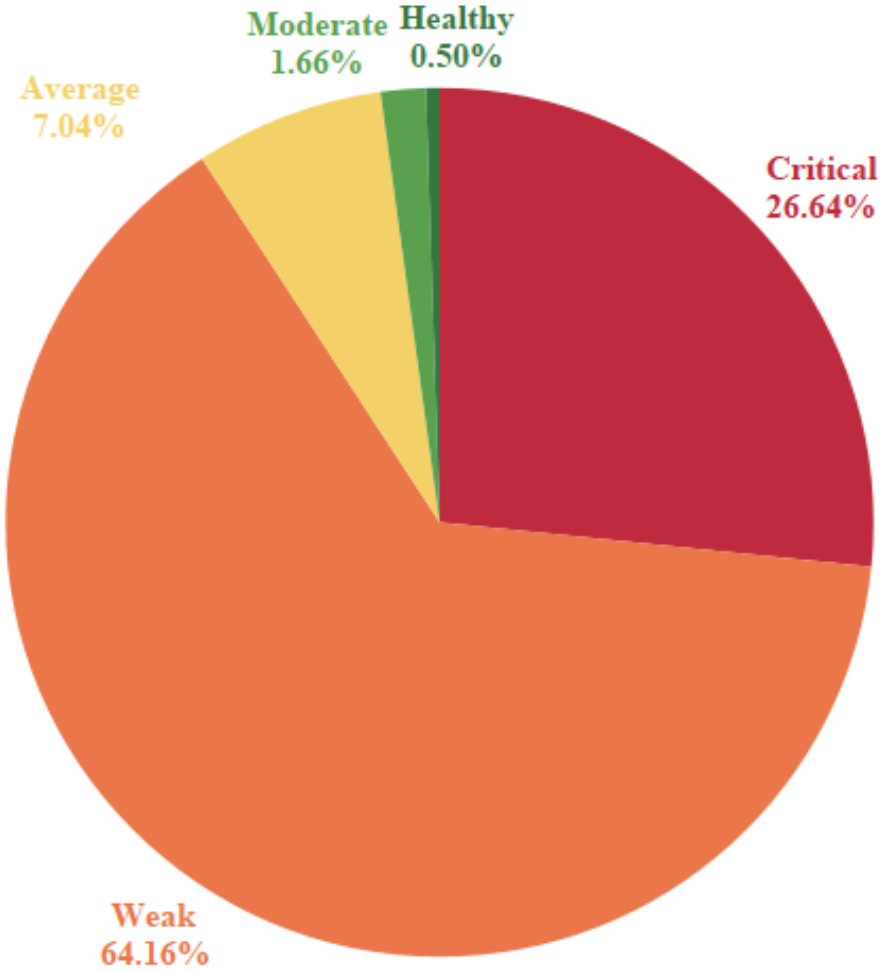
Soil Map of Punjab – Phosphorous



Soil Map of Punjab – Phosphorous



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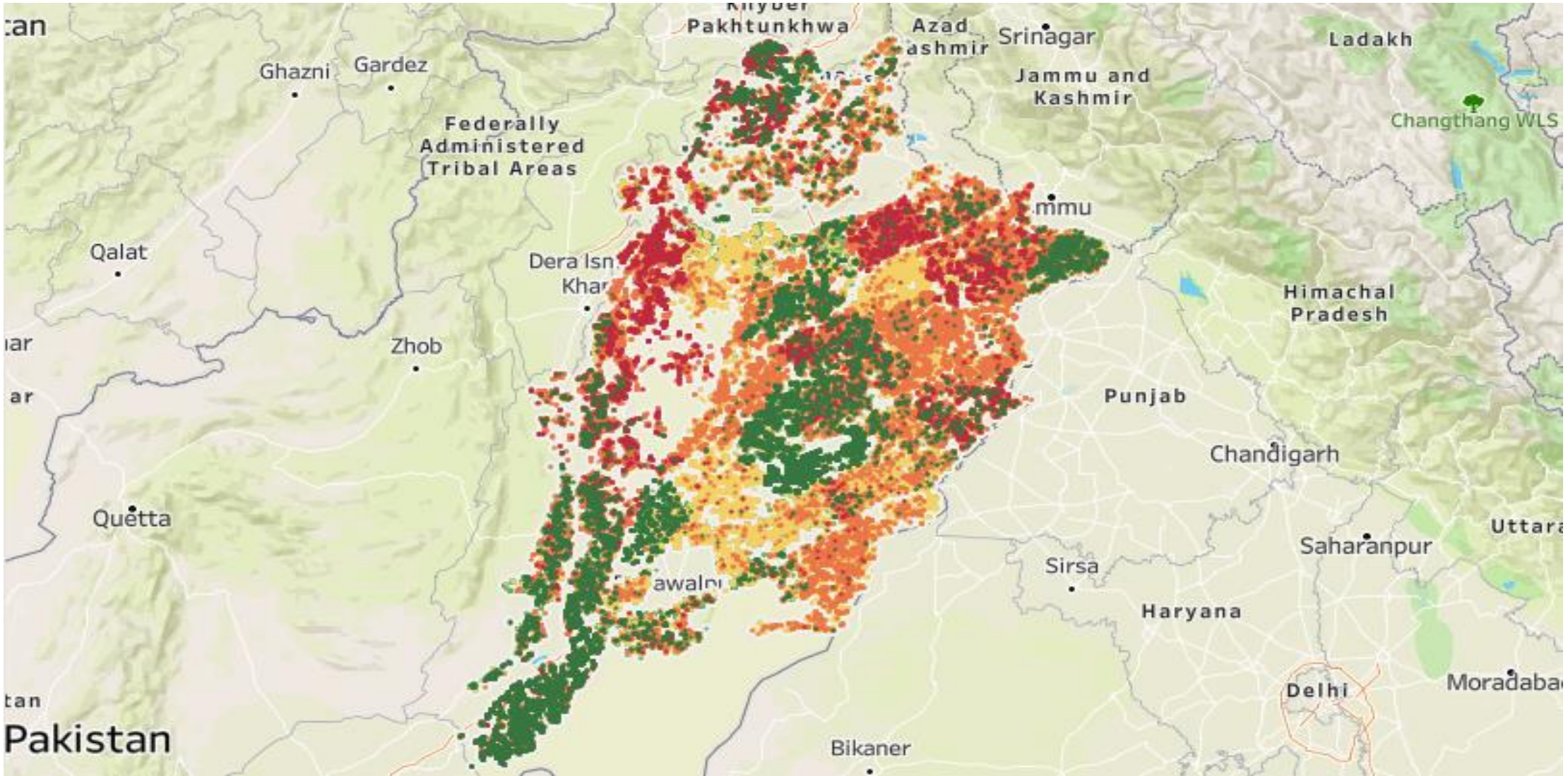
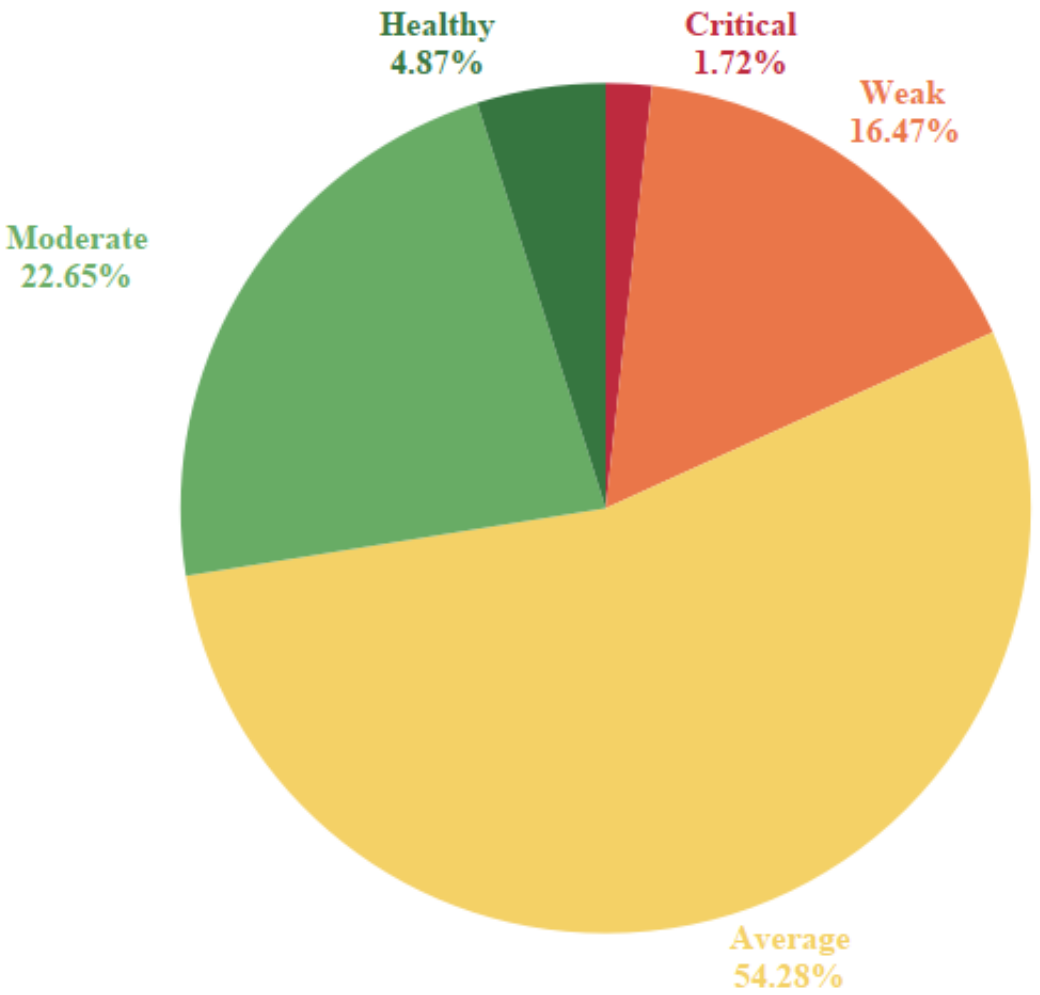
Soil map of Punjab – Potash



Soil map of Punjab – Potash



Filter Cake – Introduction

Filter cake can be defined as the residue that is eliminated during the cane juice decantation process, during the treatment stage, in sugar and/or alcohol production.

After the juice treatment decantation stage, the resulting slurry is sent to the filtration sector where residual sugar is removed, resulting in the filter cake.

Dry Filter cake

Press Mud

Composition of Filter Cake

Cake composition depends on several factors:

1. Type of soil
2. sugarcane variety
3. harvesting method (manual or mechanized),
4. juice extraction, lime dosage, and other products used for clarification,
5. filtration methods, among others.

- *Unprocessed* filters contain approximately 75% water and mean composition is presented in Table

Typical composition of filter cake from sugar industry

Components	Content (%)
	Common filter cake
C	33.73
N	2.36
CaO	1-4
P_2O_5	1-3
MgO	0.5-1.5
Wax, lipids, resin	4-14
Fiber	15-30
Protein	5-15
Total ash	9-20

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Use of Filter Cake in Agriculture

- Filter cake is utilized as fertilizer in several countries, including Brazil, India, Australia, Cuba, Pakistan, Taiwan, South Africa, and Argentina.

- **The residue is produced in large volumes 30–40 kg t^{-1} of crushed cane** (Santos et al., 2010; González et al., 2014) **and it contains a considerable amount of organic matter and mineral elements required for plant nutrition, characteristics that explain its potential for agriculture.**

- It can partially substitute for mineral fertilizers and some suggestions have been made as to the amounts to be applied in the cultivation of sugar cane.

- In Brazil, the recommended applications of filter cake pre-planting are 80–100 t ha^{-1} if applied to the whole area, 15–30 t ha^{-1} if applied in the planting grooves, or 40–50 t ha^{-1} if applied between the grooves

The main effects of filter cake on soil chemical properties are

1. Increased nitrogen, phosphorus, and calcium concentrations
2. increased cation exchange capacity (CEC), and
3. Beneficial effects on physical and biological soil properties are also observed.

Filter cake and Sugar industry of Pakistan

- Assuming 60 million ton cane production – 2.1 million tons of filter cake is produced/year.
- Typical NPK ratio is 2*1*0.3
- Maximum application 40- 50 tons/ acre
- Likely application rate is 8-10 tons/acre
- Application at the time of sowing

Filter cake properties

Determinations	Filter cake				
	(*)	[10]	[12]	[36]	Average
OM (%)	29.6	15	—	—	22.3
pH	8.2	—	7.1	—	7.7
N (%)	1.4	4.8	1.6	0.3	2.0
P (%)	1.2	1.8	1.3	0.1	1.1
K (%)	0.2	0.3	0.4	0.4	0.3
Ca (%)	2.7	1.6	2.5	1.7	2.1
Mg (%)	1.1	0.4	—	0.2	0.6
S (%)	0.2	0.3	—	—	0.25
C/N ratio	12	—	25	36	24

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Making Filter Cake more effective

- Blending rock phosphate
- Introduction of bacteria – route to bio fertilizer
- Use of Gypsum
- Enriching with secondary and micro-nutrients
- Compost production
- Vermicompost production
- Substrate for seedling production

Challenges

1. Lack of Solubility – slow action
2. Disproportionate distribution of nutrients
3. Odor during composting /decomposition
4. Freight and challenges related to distribution in the field

Conclusion

- Filter cake is NOT a direct replacement of chemical fertilizers
- Gradual application of filter cake consistently will affect
  - Soil OM
  - Phosphorous concentration
  - Physical properties such soil porosity
- Ease of application of Filter cake is an important issue
- Value addition could open result in other benefits

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Mr. Rao Masood Sb, RSML

Back up technical slide for Q&A

In another Brazilian experiment, the response of vegetative growth and productivity of sugar cane to the application of fertilizers containing filter cake enriched with soluble phosphate was studied. It was verified that phosphorus increased productivity in sugar cane and that the application of filter cake to the planting grooves could substitute for part of the inorganic phosphate fertilizer.

The best combination suggested by the authors to optimize the concentration of soluble solids and sugar production was 2.6–2.7 t ha^{-1} of filter cake in combination with 160–190 kg ha^{-1} of P_2O_5.

The beneficial effects of filter cake were also demonstrated in Brazil in a field study of ratoon cane where the application of 70 t ha^{-1} of fresh filter cake increased the production of cane sugar internodes.

Vermicomposting is an important technique for the utilization of filter cake. Filter cake has a high potential as a starting material for vermicomposting and results in a biologically stable product that is free of pathogens, as confirmed by coliform counting. In India, vermicomposting of filter cake in combination with equine manure accelerated mineralization of nutrients and was adequate for growth and reproduction of earthworms.

Other authors suggest composting as a viable use of filter cake. In countries like Thailand, enhanced performance at composting facilities for organic products needs improvements to preserve nitrogen concentration and produce a stable product in the short term.
The C/N ratio in filter cake is around 14 and in sugar cane bagasse, another sugar cane residue, it is 100. Therefore, the filter cake composting could result in considerable ammonia N loss through volatilization due to the low C/N ratio.
On the other hand, bagasse composting is only possible with the addition of N due, in this case, to the high C/N ratio.
Since composting maturation is highly dependent on the nature of organic residues, investigators in Thailand determined the time required for filter cake to compost to a stable product and considered that composting a mixture of bagasse and filter cake (2 : 1 by weight) would prevent N losses by increasing the C/N ratio. The authors concluded that nitrogen loss was reduced by 12–15% and that both products have potential use in agricultural production.
The time for complete composting took approximately 90 days.

Challenges details

- Some factors, such as lack of solubility and unbalanced concentrations of nutrients, limit the application of filter cake to soil.

- The strong disagreeable smell during biological degradation, the high temperature of the residue (65°C), and the long period of natural decomposition are additional disadvantages.

- Reports in the literature mention immobilization of nutrients and phytotoxicity after application of residues that are not composted or otherwise stabilized. Discarding the raw residue is of concern in developing countries, as for example, in India.
- Sugar Mills policy i.e Filter cake(press mud) sold through contractor, cost increases.
- Timely availability and transportation issues, difficult to manage 3-4 trollies/acre transportation.
- No quick results, raw filter cake take many months to decompose in natural environment.

Way forward details
(Composting, Vermicomposting, and Substrate)

1- Composting as a viable use of filter cake. In countries like Thailand, enhanced performance at composting facilities for organic products needs improvements to preserve nitrogen concentration and produce a stable product in the short term.

2- Vermicomposting is an important technique for the utilization of filter cake. Filter cake has a high potential as a starting material for vermicomposting and results in a biologically stable product that is free of pathogens, as confirmed by coliform counting. In India, vermicomposting of filter cake in combination with equine manure accelerated mineralization of nutrients and was adequate for growth and reproduction of earthworms.

3- Another application for filter cake is as a substrate for seedling production.
Some trials conducted in Brazil have indicated that filter cake mixed with bagasse could be an adequate substrate for the production of eucalyptus and citrus seedlings.

In a report from India the combined application of N (0, 75, 100, and 150 kg ha^{-1}) and filter cake (0, 10, 20, 30 t ha^{-1}, with 80% water content) to sugar cane indicated that 10 t ha^{-1} of filter cake together with 75 kg ha^{-1} N produced equivalent yields to 150 kg ha^{-1} N, resulting in the saving of 75 kg ha^{-1} of chemical N fertilizer.

Studies conducted in Brazil evaluated the effects of filter cake in combination with mineral fertilizers (0, 50, and 100% of the recommended dose) in sugar cane production. It was observed that filter cake improved soil fertility, expressed as increased concentrations of macro- and micronutrients, and reduced soil acidity and concentrations of soil aluminum.

Sugar cane plants showed a positive response to the addition of filter cake through increased concentrations of phosphorus, potassium, and copper in the aerial parts.

The authors concluded that the use of filter cake in combination with mineral fertilizers can maximize productivity and reduce the costs associated with mineral fertilizers.

In a study conducted in Indonesia, ashes of rice husks and filter cake were applied at two amounts to cabbages and phosphorus availability in soil, phosphorus uptake by plants, and plant growth were determined.

The results indicated that phosphorus availability increased 120% and 78%, when rice husk ashes and filter cake were applied, respectively. The treatments increased silicon concentrations, cation exchange capacity, solution pH, and anion concentrations in the soil.

The authors also observed that in soils containing high amounts of organic matter, addition of rice ashes and filter cake increased phosphorus uptake 3-fold and 2-fold and increased plant growth by 197% and 231%, respectively.

In soils poor in organic matter addition of rice ashes and filter cake increased phosphorus uptake by 1.9-fold and 2.7-fold and increased plant growth by 17% and 11.9%, respectively, compared to untreated soils.

Another study in Swaziland reports that the use of filter cake application is of great importance due to limited funds to buy chemical fertilizers in addition to its environmental benefits. The authors studied the application of different amounts of filter cake in maize cultivation (0, 10, 20, 40 t ha^{-1}) and reported that the higher applications increased soil organic matter.

Soil phosphorus concentrations increased from 6 mg kg^{-1} (without fertilizer) to 56 mg kg^{-1}, while treatments with mineral fertilizer led to a phosphorus concentration of only 24 mg kg^{-1}. Micronutrient concentrations were also increased, with exception of boron and copper.

Maize yields were also increased by the addition of filter cake. Yields of maize crops receiving the largest amounts of filter cake (5,254 kg ha^{-1}) were comparable to those receiving chemical fertilizers (5,046 kg ha^{-1}), and both were much larger than the control treatment (3,732 kg ha^{-1}).

Effects of Filter Cake Application on the Production and Quality of Various Crops

The productivity of sugar cane crops receiving organic and mineral fertilizers was analyzed in a study conducted in Cuba. It was observed that soil structure was improved when natural and organic fertilizers were used rather than chemical fertilizers. The authors reported that application of 15 t ha^{-1} of filter cake plus 2 t ha^{-1} zeolite, 4 t ha^{-1} of compost and 2 t ha^{-1} of phosphate and calcareous rock had better residual effects on soil properties that were reflected in the agricultural and industrial yield of sugar cane for over three years.

In Swaziland, the destination of filter cake is a problem to the country. It is not widely used as a fertilizer, but one report considers that this organic product should be better studied and used, for example, in the cultivation of manioc(root crop), in a similar manner to maize and sweet potato cultivation.

There are indications that addition of filter cake at 60 t ha^{-1} has potential as an organic amendment in manioc production by preventing competition with weeds and increasing productivity by 50% compared to mineral fertilization.