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Groundnut Fertility and Soil pH

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Major Nutrients Required by Groundnut

Element	Consideration
Nitrogen	Inoculation (*Rhizobia*)
Phosphorus, Potassium, and Magnesium	Potassium and magnesium interference with calcium
Calcium	Pod development
Manganese	pH dependent
Boron	Pod development
Zinc	Toxicity at low pH
Lime	5.8 to 6.2

Improving cultivation of groundnuts

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Table 1 Estimated nutrients required to produce selected pod yields of groundnut

	Quantity (Kg/ha)[1]									
Pod yield (Kg/ha)	N	P	K	Ca	Mg	S	Fe	Mn	Zn	B
1000	58	5	18	11	9	4	2	0.09	0.08	0.05
2000	117	10	36	23	18	9	4	0.19	0.16	0.11
3000	174	15	54	34	27	13	6	0.29	0.24	0.16
4000	232	20	73	45	36	18	8	0.38	0.32	0.22
5000	290	25	91	56	45	22	10	0.48	0.41	0.27
6000	348	30	109	68	54	26	12	0.58	0.49	0.33
7000	406	35	126	77	63	30	14	0.68	0.56	0.38
8000	464	40	144	88	72	34	16	0.78	0.64	0.44
9000	522	45	162	99	81	38	18	0.88	0.72	0.49
10 000	580	50	180	110	90	42	20	0.98	0.80	0.54

[1] Calculation based on Sahrawat, Srinivas Rao, and Nambiar. 1988. *Plant and Soil* 109:291–293.

Soil pH

Soil pH is a critical component of crop production

Response to nutrients is very often dictated by soil pH (correct pH often corrects deficiencies and prevents toxicity)

Optimum pH to optimize groundnut yield is 5.8 to 6.2

Low pH negatively affects nodule development in groundnut and subsequent biological nitrogen fixation (BNF)

Table 3-3. Crop Response to Soil pH

Approximate Soil pH	Percentage of Yield at Lower pH Values Compared with Yield at pH 5.9					
	Corn	Cotton	Peanut	Soybean	Wheat	Grain Sorghum
4.3	26	24	55	45	41	78
4.9	76	57	62	62	72	83
5.4	99	89	83	90	100	94
5.9	100	100	100	100	100	100
Years	2	2	3	2	2	2

Groundnut and other crops respond in a positive manner when soil is limed to the optimum pH. In North Carolina low pH often results in aluminum toxicity.


Nitrogen-deficient peanut

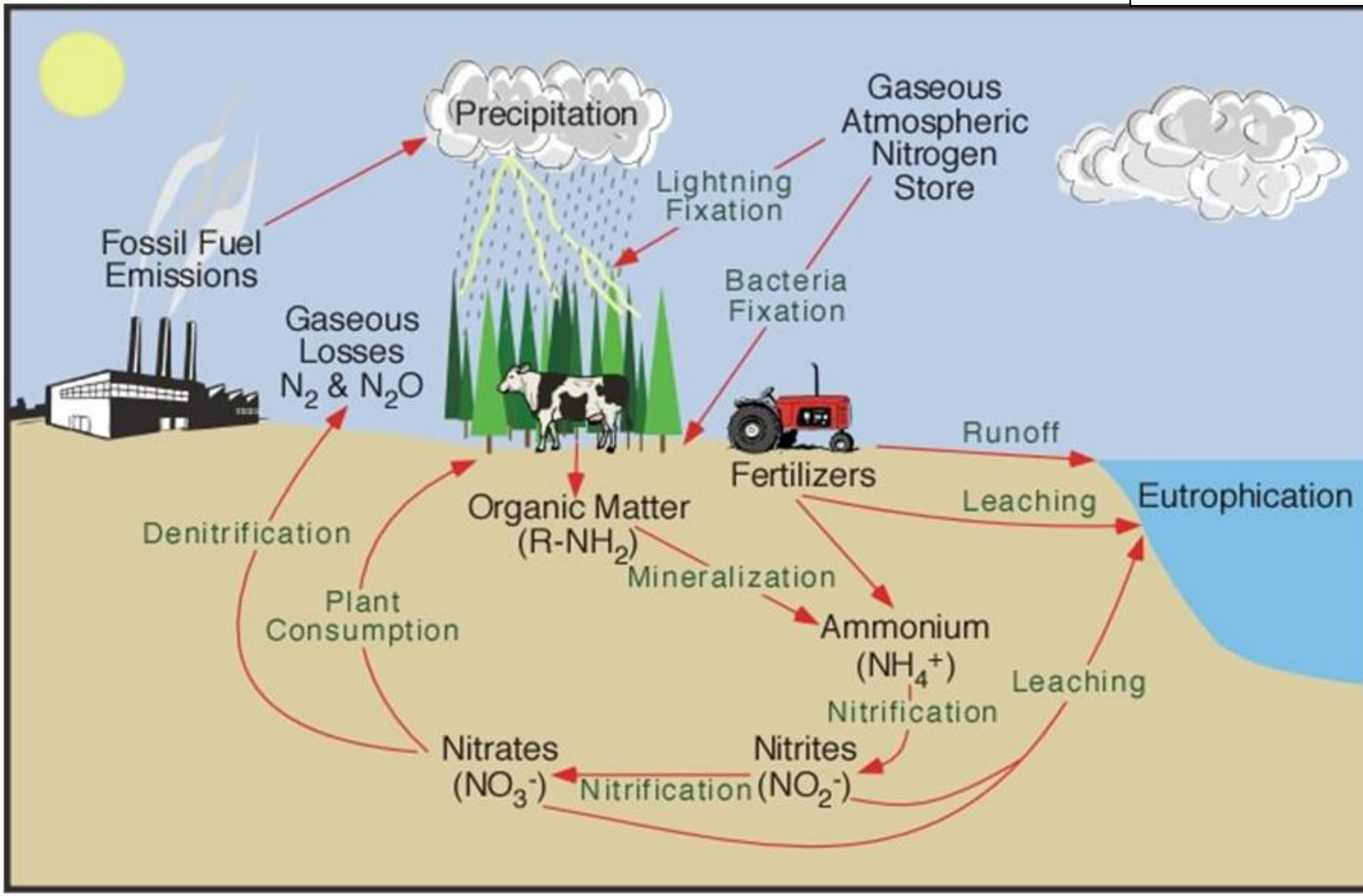

Figure 9s-1: Nitrogen cycle.

Citation: Pidwirny, M. (2006). "The Nitrogen Cycle". *Fundamentals of Physical Geography, 2nd Edition*. Date Viewed. http://www.physicalgeography.net/fundamentals/9s.html

Nodules in a symbiotic relationship with the plant resulting in conversion of atmospheric nitrogen into a plant usable form

Images by Bridget Lassiter

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Micronutrients are essential:
Molydenum
Iron

Images by Bridget Lassiter

Inoculant Sources and Issues

- In-furrow granular
- In-furrow sprays
- Hopper Box treatments with seed
- **Coating seed with inoculant**
- "Native" inoculum
- Short versus long rotations
- Does the strain(s) in a commercial inoculant perform well under local conditions?

Table 3-5. Peanut Yield Response and Economic Return at a Price of $535 per ton in Fields without a History of Peanuts versus Fields with Frequent Plantings of Peanuts (1999 – 2016)

Inoculant Use	New Peanut Fields		Fields with a Recent History of Peanuts	
	Yield (lb per acre)	Economic return ($ per acre)	Yield (lb per acre)	Economic return ($ per acre)
No inoculant	3,571	39	4,282	229
Inoculant	5,133	449	4,475	273
Difference	1,562	410	193	44
Number of Trials	39	39	36	36
Years	1999 – 2016		1999 – 2016	

A greater response is often observed in fields that do not have an history of groundnut but a positive but more modest response can occur in shorter rotations. pH in these fields was often 5.6 to 6.2.

Poor Performance of *Bradyrhizobia*

- **Are strains suitable for the local environment?**
- **Old product or "mistreated" product**
- **Non-uniform application**
- Poor water quality
- Caving in of planted slit before application but after seed drop
- Incompatibility with other agrichemicals or fertilizers
- Mixed in tank too long prior to application
- **Shallow planting (warm/hot soils will kill the bacteria)**
- **Low pH, Molybdenum deficiency**

Peanut yield response to inoculation as influenced by rotation

Inoculant applied in-furrow as a liquid or granular product

Trials	Range of years out of peanut	Response to rotation	Response to inoculation
1	0-5	Yes	No
2	1-3	Yes	Yes
3	0-5	Yes	No
4	2-5	Yes	Yes

Response to *Bradyrhizobia* inoculant can be unpredictable and may not be explained by cropping history.

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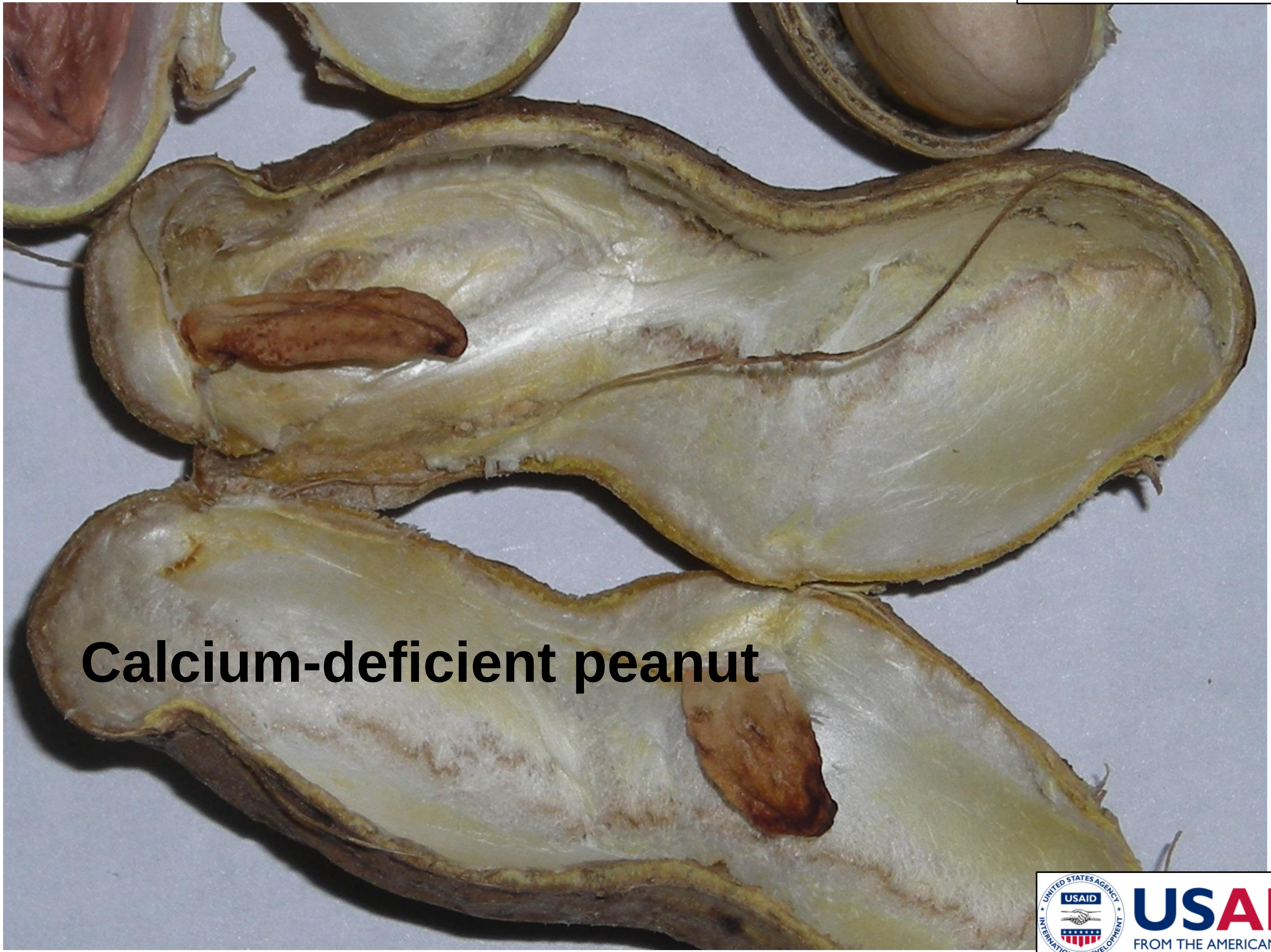

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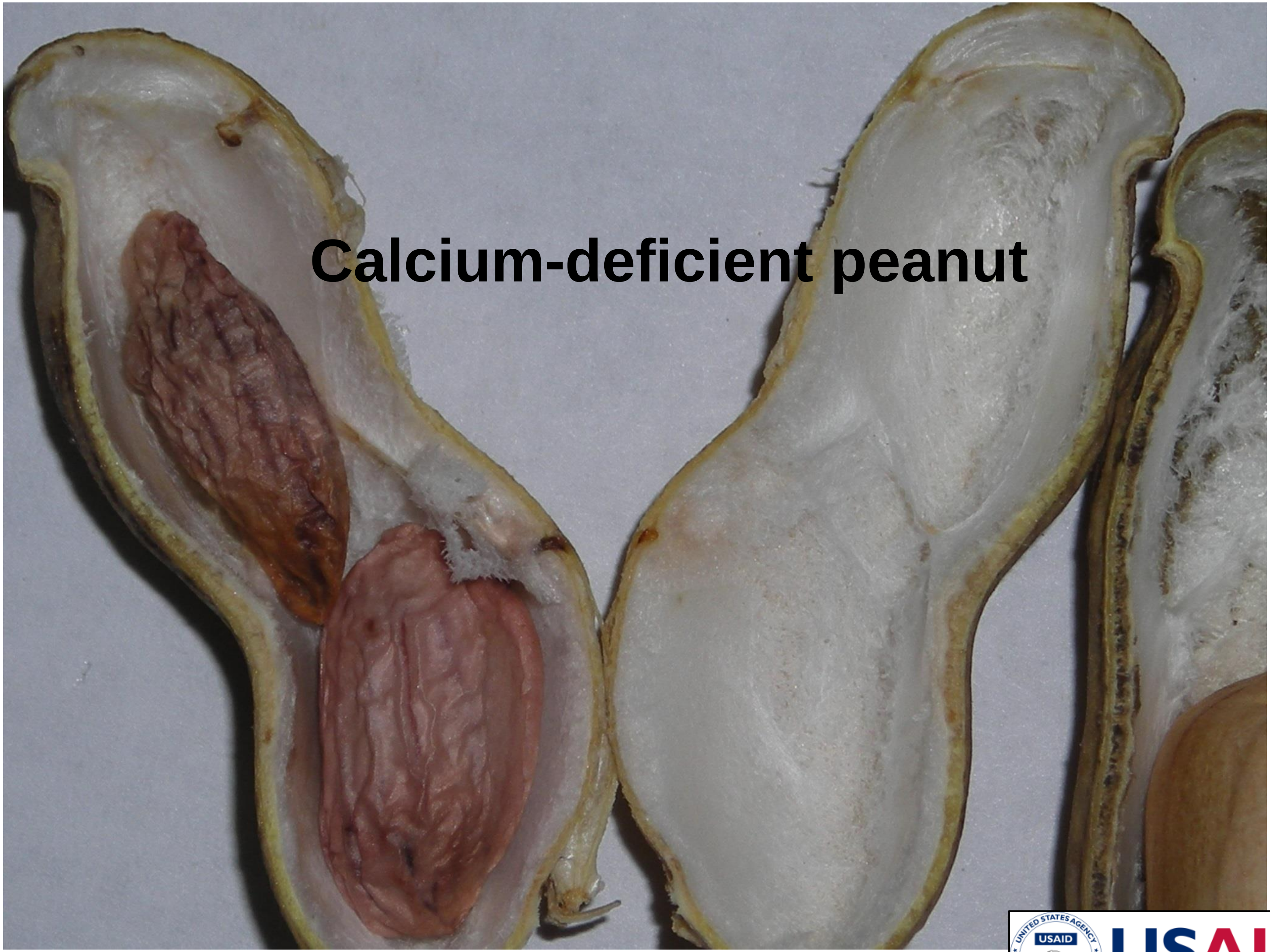
Calcium-deficient peanut



Important for seed production! Germination and seedling vigor is not just an issue with drying and storing!

Factors that Affect Peanut Response to Calcium

- Seed size
- Rainfall or irrigation
- Soil texture and organic matter
- Soil pH
- Nutrient balance

Table 3-7. Gypsum Sources and Application Rates

Source	% $CaSO_4$*	Application Rate (lb/acre)	
		Band (16-18 in)	Broadcast
USG Ben Franklin	85	600	—
USG 420 Granular	83	—	1,215
USG 500	70	—	1,300
Super Gyp 85	85	—	1,200
TG Phosphogypsum	50	—	2,000
Agri Gypsum	60	—	1,800
Gyp Soil	85	—	1,200

*Guaranteed analysis percentage in registration with North Carolina Department of Agriculture and Consumer Services.

Make sure the source of calcium is an approved source with known elements and is water soluble. Lime is not a substitute for calcium at flowering.

Table 3-8. Pod Yield Following Application of Gypsum at 0.5 and 1 Times (X) the Recommended Use Rate for Virginia Market Types.

Pod Yield (lb/acre)	No. of Trials	Pod Yield (lb/acre) No Gypsum	0.5X Gypsum	1.0X Gypsum
Actual yield	12	3,970	4,510	4,590
Increase in yield over no-gypsum control	—	—	540	620

Response to calcium at flowering can be variable. At times higher rates are only marginally effective but response is affected by numerous factors.

Table 3-4. Peanut Response to Gypsum Rate at Three Soil pH Values

Relative Gypsum Rate	Soil pH		
	5.0	5.5	6.0
0	1,920	2,720	2,900
0.5X	1,930	2,690	3,320
1.0X	2,110	2,190	3,250

Data are pooled over three years.

Greatest response to calcium at flowering occurs when pH is at optimum. At lower pH levels response can be minimal and possibly negative.

Balance and appropriate ratios of nutrients are just as important as the total amount! The value of an appropriate soil pH cannot be underestimated!

Zinc Toxicity

- pH below 6.0 and soil Zinc concentrations above 10 ppm (MI extractable) could cause zinc toxicity
- Critical level of 250 (index), but the critical level could be lower if pH is lower

Zinc toxicity

Boron toxicity

Manganese deficiency

Addressing Fertility Issues in Malawi

Lime to achieve pH of at least 5.8 if economically feasible

Determine soil levels of P, K, Mg, Ca, etc.

Inoculate with *Bradyrhizobia* if a known and dependable source is readily available

If a dependable source of *Bradyrhizobia* is not available, apply an adequate amount of nitrogen fertilizer

Apply calcium at flowering, especially for larger-seeded groundnut varieties

Avoid salt damage from irrigation sources