

Empowering farmers with artificial intelligence: a retrieval-augmented generation based large language model advisory framework

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SUPPLEMENTARY MATERIAL

Section S1. Prompt Template

PROMPT_TEMPLATE = """

You are an agricultural expert. Answer the question using ONLY the provided context below.

CRITICAL REQUIREMENT: You MUST cite every fact by including [Source ID: X] immediately after each statement, where X is the source number (1, 2, or 3).

Context:

{context}

Question: {question}

Instructions:

- Provide a complete, accurate answer
- After EVERY factual claim, add [Source ID: X] where X is 1, 2, or 3
- Use multiple sources if they support different parts of your answer
- Do not make claims without citing a source

Answer with citations:

"""

Section S2. Benchmark Queries

Table S1. Benchmark Queries for Evaluation of the RAG-Based Agricultural Advisory System.

Query	Query_ID
what are the main planting seasons for maize?	Maize_Query1
what are some important hybrid and composite varieties of maize?	Maize_Query2
what are the optimal environmental and soil conditions required for maize cultivation?	Maize_Query3
how frequently should maize be irrigated during the initial growth period?	Maize_Query4
what is the recommended timing for weeding operations in maize crops?	Maize_Query5
what is the recommended fertilizer application schedule and dosage for maize cultivation?	Maize_Query6
what are the main planting seasons for sweet potato?	Sweet_Potato_Query1
what are the varieties of sweet potato?	Sweet_Potato_Query2
how frequently should sweet potato be irrigated during the initial growth period?	Sweet_Potato_Query3
what is the recommended timing for weeding operations in sweet potato crops?	Sweet_Potato_Query4
what is the recommended manuring and fertilizer application schedule and dosage for sweet potato cultivation?	Sweet_Potato_Query5
what are the different growing seasons for ragi cultivation?	Ragi_Query1
what are the main varieties of ragi?	Ragi_Query2
what are the optimal environmental and soil conditions required for ragi cultivation?	Ragi_Query3
what is the recommended irrigation schedule for ragi after transplantation?	Ragi_Query4
what is the recommended timing for weeding operations in ragi crops?	Ragi_Query5
what is the recommended fertilizer application schedule and dosage for ragi cultivation?	Ragi_Query6
what are the different growing seasons for cotton cultivation?	Cotton_Query1
what are the main varieties of cotton?	Cotton_Query2
what are the optimal environmental and soil conditions required for cotton cultivation?	Cotton_Query3
how frequently should cotton be irrigated during the initial growth period?	Cotton_Query4
what is the recommended manuring and fertilizer application schedule and dosage for cotton cultivation?	Cotton_Query5
what are the different growing seasons for groundnut cultivation?	Groundnut_Query1

what are some important varieties of groundnut?	Groundnut_Query2
what are the sowing specifications for groundnut?	Groundnut_Query3
how frequently should groundnut be irrigated during the initial growth period?	Groundnut_Query4
what is the recommended manuring and fertilizer application schedule and dosage for groundnut cultivation?	Groundnut_Query5

Section S3. Detailed Per Query Results**Table S2.** Query-wise Retrieval and Generation Times for all LLMs

Crop	LLM	Query	Retrieval Time(s)	Generation Time(s)	Total Time(s)
Maize	mistral	Maize_Query1	1.12	9.8	10.92
Maize	mistral	Maize_Query2	1.87	25.12	26.99
Maize	mistral	Maize_Query3	1.06	19.26	20.32
Maize	mistral	Maize_Query4	1.05	9.79	10.84
Maize	mistral	Maize_Query5	1.12	9.21	10.33
Maize	mistral	Maize_Query6	1.05	20.81	21.86
Sweet Potato	mistral	Sweet_Potato_Query1	1.08	9.35	10.43
Sweet Potato	mistral	Sweet_Potato_Query2	1.06	11.44	12.5
Sweet Potato	mistral	Sweet_Potato_Query3	1.1	7.81	8.91
Sweet Potato	mistral	Sweet_Potato_Query4	1.07	6.44	7.51
Sweet Potato	mistral	Sweet_Potato_Query5	1.09	24.24	25.33
Ragi	mistral	Ragi_Query1	1.1	11.68	12.78
Ragi	mistral	Ragi_Query2	1.1	7.84	8.94
Ragi	mistral	Ragi_Query3	1.08	16.12	17.2
Ragi	mistral	Ragi_Query4	1.09	10.04	11.13
Ragi	mistral	Ragi_Query5	1.09	6.11	7.2
Ragi	mistral	Ragi_Query6	1.04	11.12	12.16
Cotton	mistral	Cotton_Query1	1.15	8.56	9.71
Cotton	mistral	Cotton_Query2	1.05	9.29	10.34
Cotton	mistral	Cotton_Query3	1.11	12.26	13.37
Cotton	mistral	Cotton_Query4	1.12	11.94	13.06
Cotton	mistral	Cotton_Query5	1.05	19.92	20.97
Groundnut	mistral	Groundnut_Query1	1.06	9.69	10.75

Groundnut	mistral	Groundnut_Query2	1.04	10.4	11.44
Groundnut	mistral	Groundnut_Query3	1.05	12.8	13.85
Groundnut	mistral	Groundnut_Query4	1.05	7.92	8.97
Groundnut	mistral	Groundnut_Query5	1.09	15.92	17.01
Maize	llama3.1	Maize_Query1	1.14	24.63	25.77
Maize	llama3.1	Maize_Query2	1.03	16.3	17.33
Maize	llama3.1	Maize_Query3	1.05	16.78	17.83
Maize	llama3.1	Maize_Query4	1.1	21.52	22.62
Maize	llama3.1	Maize_Query5	1.04	13.28	14.32
Maize	llama3.1	Maize_Query6	1.06	35.65	36.71
Sweet Potato	llama3.1	Sweet_Potato_Query1	1.04	6.42	7.46
Sweet Potato	llama3.1	Sweet_Potato_Query2	1.07	16.75	17.82
Sweet Potato	llama3.1	Sweet_Potato_Query3	1.1	13.18	14.28
Sweet Potato	llama3.1	Sweet_Potato_Query4	1.04	17.28	18.32
Sweet Potato	llama3.1	Sweet_Potato_Query5	1.03	20.05	21.08
Ragi	llama3.1	Ragi_Query1	1.03	15.13	16.16
Ragi	llama3.1	Ragi_Query2	1.05	11.17	12.22
Ragi	llama3.1	Ragi_Query3	1.02	23.24	24.26
Ragi	llama3.1	Ragi_Query4	1.04	21.03	22.07
Ragi	llama3.1	Ragi_Query5	1.04	8.54	9.58
Ragi	llama3.1	Ragi_Query6	1.15	15.32	16.47
Cotton	llama3.1	Cotton_Query1	1.03	17.96	18.99
Cotton	llama3.1	Cotton_Query2	1.03	13.77	14.8
Cotton	llama3.1	Cotton_Query3	1.04	12.86	13.9
Cotton	llama3.1	Cotton_Query4	1.05	16.08	17.13
Cotton	llama3.1	Cotton_Query5	1.02	23.71	24.73

Groundnut	llama3.1	Groundnut_Query1	1.04	17.58	18.62
Groundnut	llama3.1	Groundnut_Query2	1.04	10.48	11.52
Groundnut	llama3.1	Groundnut_Query3	1.1	18.89	19.99
Groundnut	llama3.1	Groundnut_Query4	1.01	9.68	10.69
Groundnut	llama3.1	Groundnut_Query5	1.09	18.65	19.74
Maize	phi3	Maize_Query1	1.07	29.45	30.52
Maize	phi3	Maize_Query2	1.07	7.84	8.91
Maize	phi3	Maize_Query3	1.05	10.16	11.21
Maize	phi3	Maize_Query4	1.03	9.87	10.9
Maize	phi3	Maize_Query5	1.02	5.21	6.23
Maize	phi3	Maize_Query6	1.07	8.51	9.58
Sweet Potato	phi3	Sweet_Potato_Query1	1.09	14.44	15.53
Sweet Potato	phi3	Sweet_Potato_Query2	1.03	6.46	7.49
Sweet Potato	phi3	Sweet_Potato_Query3	1.05	6.64	7.69
Sweet Potato	phi3	Sweet_Potato_Query4	1.07	6.39	7.46
Sweet Potato	phi3	Sweet_Potato_Query5	1.04	33.43	34.47
Ragi	phi3	Ragi_Query1	1.03	8.17	9.2
Ragi	phi3	Ragi_Query2	1.09	3.83	4.92
Ragi	phi3	Ragi_Query3	1.03	4.47	5.5
Ragi	phi3	Ragi_Query4	1.11	9.26	10.37
Ragi	phi3	Ragi_Query5	1.05	3.43	4.48
Ragi	phi3	Ragi_Query6	1.04	6.31	7.35
Cotton	phi3	Cotton_Query1	1.09	7.42	8.51
Cotton	phi3	Cotton_Query2	1.08	5.38	6.46
Cotton	phi3	Cotton_Query3	1.05	16.34	17.39

Cotton	phi3	Cotton_Query4	1.06	5.5	6.56
Cotton	phi3	Cotton_Query5	1.06	12.5	13.56
Groundnut	phi3	Groundnut_Query1	1.08	5.44	6.52
Groundnut	phi3	Groundnut_Query2	1.06	5.36	6.42
Groundnut	phi3	Groundnut_Query3	1.05	9.15	10.2
Groundnut	phi3	Groundnut_Query4	1.07	5.23	6.3
Groundnut	phi3	Groundnut_Query5	1.05	9.99	11.04
Maize	qwen2.5	Maize_Query1	1.08	22.02	23.1
Maize	qwen2.5	Maize_Query2	1.04	7.94	8.98
Maize	qwen2.5	Maize_Query3	1.03	18.25	19.28
Maize	qwen2.5	Maize_Query4	1.05	12.29	13.34
Maize	qwen2.5	Maize_Query5	1.04	7.16	8.2
Maize	qwen2.5	Maize_Query6	1.09	14.67	15.76
Sweet Potato	qwen2.5	Sweet_Potato_Query1	1.76	21.94	23.7
Sweet Potato	qwen2.5	Sweet_Potato_Query2	1.02	13.78	14.8
Sweet Potato	qwen2.5	Sweet_Potato_Query3	1.9	23.96	25.86
Sweet Potato	qwen2.5	Sweet_Potato_Query4	1.21	7.8	9.01
Sweet Potato	qwen2.5	Sweet_Potato_Query5	1.23	20.5	21.73
Ragi	qwen2.5	Ragi_Query1	1.31	15.37	16.68
Ragi	qwen2.5	Ragi_Query2	1.1	10.36	11.46
Ragi	qwen2.5	Ragi_Query3	1.23	23.7	24.93
Ragi	qwen2.5	Ragi_Query4	1.25	9.51	10.76
Ragi	qwen2.5	Ragi_Query5	1.26	3.81	5.07
Ragi	qwen2.5	Ragi_Query6	1.15	11.04	12.19
Cotton	qwen2.5	Cotton_Query1	1.3	10.31	11.61

Cotton	qwen2.5	Cotton_Query2	1.22	12.53	13.75
Cotton	qwen2.5	Cotton_Query3	1.24	22.03	23.27
Cotton	qwen2.5	Cotton_Query4	1.19	13.98	15.17
Cotton	qwen2.5	Cotton_Query5	1.17	16.43	17.6
Groundnut	qwen2.5	Groundnut_Query1	1.21	12.05	13.26
Groundnut	qwen2.5	Groundnut_Query2	1.2	14.41	15.61
Groundnut	qwen2.5	Groundnut_Query3	1.21	14.72	15.93
Groundnut	qwen2.5	Groundnut_Query4	1.19	10.4	11.59
Groundnut	qwen2.5	Groundnut_Query5	1.19	13.69	14.88

Table S3. Performance Metrics for LLM Responses Across Crops and Queries

Crop	LLM	Query	BLEU	ROUG E-1	ROUGE- 2	ROUG E-L	BERTSc ore_P	BERTSc ore_R	BERTSc ore_F1
Maize	mistral	Maize_Qu ery1	0.0781	0.72	0.5417	0.68	0.9124	0.9534	0.9325
Maize	mistral	Maize_Qu ery2	0.0277	0.283	0.1923	0.283	0.8505	0.9011	0.8751
Maize	mistral	Maize_Qu ery3	0.1183	0.4	0.307	0.313	0.8304	0.9464	0.8846
Maize	mistral	Maize_Qu ery4	0.0083	0.3111	0	0.1556	0.8422	0.8918	0.8663
Maize	mistral	Maize_Qu ery5	0.0966	0.2927	0.25	0.2927	0.8453	0.9337	0.8873
Maize	mistral	Maize_Qu ery6	0.0693	0.403	0.2069	0.2586	0.8292	0.8918	0.8593
Sweet Potato	mistral	Sweet_Pot ato_Query 1	0.0079	0.2692	0.0196	0.1538	0.8313	0.8862	0.8579
Sweet Potato	mistral	Sweet_Pot ato_Query 2	0.1051	0.4354	0.2207	0.3401	0.8799	0.8843	0.8821
Sweet Potato	mistral	Sweet_Pot ato_Query 3	0.052	0.2969	0.0794	0.2031	0.8586	0.8432	0.8508
Sweet Potato	mistral	Sweet_Pot ato_Query 4	0.2551	0.5128	0.3784	0.5128	0.8812	0.9121	0.8964
Sweet Potato	mistral	Sweet_Pot ato_Query 5	0.0474	0.3659	0.1778	0.2397	0.8253	0.8939	0.8582
Ragi	mistral	Ragi_Quer y1	0.0132	0.3621	0.0877	0.2759	0.8315	0.8947	0.8619
Ragi	mistral	Ragi_Quer y2	0.083	0.7	0.6842	0.7	0.8872	0.922	0.9043
Ragi	mistral	Ragi_Quer y3	0.0961	0.4	0.2383	0.2564	0.8192	0.9103	0.8624
Ragi	mistral	Ragi_Quer y4	0.0069	0.2195	0	0.122	0.8174	0.8911	0.8526
Ragi	mistral	Ragi_Quer y5	0.0627	0.303	0.1935	0.303	0.8714	0.8933	0.8822

Ragi	mistral	Ragi_Query6	0.0301	0.3333	0.0893	0.2632	0.8474	0.8796	0.8632
Cotton	mistral	Cotton_Query1	0	0.3462	0.16	0.3462	0.8446	0.8896	0.8665
Cotton	mistral	Cotton_Query2	0.0368	0.4912	0.2545	0.2807	0.8592	0.9147	0.8861
Cotton	mistral	Cotton_Query3	0.0724	0.5217	0.1765	0.2464	0.8333	0.8967	0.8638
Cotton	mistral	Cotton_Query4	0.1146	0.3636	0.2521	0.3471	0.8556	0.9455	0.8983
Cotton	mistral	Cotton_Query5	0.0183	0.241	0.0729	0.1767	0.8145	0.8688	0.8408
Groundnut	mistral	Groundnut_Query1	0.0814	0.4048	0.2683	0.381	0.8726	0.937	0.9037
Groundnut	mistral	Groundnut_Query2	0.0164	0.2632	0.0811	0.2105	0.8357	0.9003	0.8668
Groundnut	mistral	Groundnut_Query3	0.006	0.194	0.0152	0.1045	0.8001	0.8294	0.8145
Groundnut	mistral	Groundnut_Query4	0.0263	0.3544	0.0519	0.2532	0.8839	0.877	0.8805
Groundnut	mistral	Groundnut_Query5	0.0097	0.3027	0.0546	0.173	0.8166	0.8471	0.8316
Maize	llama3.1	Maize_Query1	0.019	0.3784	0.1944	0.2973	0.8488	0.9243	0.8849
Maize	llama3.1	Maize_Query2	0.0048	0.35	0.1356	0.35	0.7939	0.9051	0.8459
Maize	llama3.1	Maize_Query3	0.2487	0.5829	0.5087	0.56	0.8664	0.9655	0.9133
Maize	llama3.1	Maize_Query4	0.0053	0.1339	0.0169	0.1004	0.7957	0.8595	0.8264
Maize	llama3.1	Maize_Query5	0.0749	0.2051	0.1739	0.2051	0.8165	0.9299	0.8695
Maize	llama3.1	Maize_Query6	0.0187	0.2379	0.0927	0.1553	0.7812	0.8568	0.8173
Sweet Potato	llama3.1	Sweet_Potato_Query1	0.0136	0.2909	0.0377	0.1818	0.8555	0.873	0.8641

Sweet Potato	llama3.1	Sweet_Potato_Query2	0.0686	0.3925	0.1981	0.2897	0.8586	0.8889	0.8735
Sweet Potato	llama3.1	Sweet_Potato_Query3	0.0278	0.3351	0.1058	0.2094	0.8318	0.8441	0.8379
Sweet Potato	llama3.1	Sweet_Potato_Query4	0.0134	0.1361	0.0529	0.1152	0.7978	0.8675	0.8312
Sweet Potato	llama3.1	Sweet_Potato_Query5	0.0714	0.5286	0.3022	0.3172	0.8358	0.9079	0.8704
Ragi	llama3.1	Ragi_Query1	0.0945	0.4405	0.253	0.3333	0.8489	0.9202	0.8831
Ragi	llama3.1	Ragi_Query2	0.0038	0.2308	0.1569	0.2308	0.8088	0.894	0.8493
Ragi	llama3.1	Ragi_Query3	0.1995	0.4539	0.4143	0.4255	0.8273	0.9401	0.8801
Ragi	llama3.1	Ragi_Query4	0.0052	0.1009	0.0093	0.0642	0.7986	0.8873	0.8406
Ragi	llama3.1	Ragi_Query5	0.0361	0.2093	0.0714	0.1395	0.831	0.8991	0.8637
Ragi	llama3.1	Ragi_Query6	0.0139	0.2151	0.0543	0.172	0.8108	0.8794	0.8437
Cotton	llama3.1	Cotton_Query1	0.0142	0.1871	0.0473	0.1287	0.796	0.894	0.8421
Cotton	llama3.1	Cotton_Query2	0.0051	0.2314	0.1008	0.1653	0.8056	0.896	0.8484
Cotton	llama3.1	Cotton_Query3	0.214	0.5987	0.3871	0.4968	0.8738	0.9419	0.9066
Cotton	llama3.1	Cotton_Query4	0.0086	0.2092	0.0397	0.1438	0.8124	0.885	0.8472
Cotton	llama3.1	Cotton_Query5	0.0168	0.2566	0.076	0.1887	0.8008	0.8674	0.8328
Groundnut	llama3.1	Groundnut_Query1	0.0145	0.1928	0.0976	0.1566	0.8033	0.9001	0.8489
Groundnut	llama3.1	Groundnut_Query2	0.0069	0.25	0.0638	0.1458	0.8324	0.8791	0.8551
Groundnut	llama3.1	Groundnut_Query3	0.008	0.2128	0.0323	0.117	0.7985	0.8519	0.8243

Groundnut	llama3.1	Groundnut_Query4	0.0132	0.2881	0.0345	0.1864	0.8354	0.8692	0.852
Groundnut	llama3.1	Groundnut_Query5	0.0064	0.2167	0.0336	0.1333	0.8031	0.8405	0.8214
Maize	phi3	Maize_Query1	0.0168	0.3768	0.0896	0.3188	0.8439	0.9191	0.8799
Maize	phi3	Maize_Query2	0.0043	0.2857	0.1241	0.2857	0.8157	0.9293	0.8688
Maize	phi3	Maize_Query3	0.0881	0.3367	0.2508	0.303	0.8071	0.9569	0.8756
Maize	phi3	Maize_Query4	0.0045	0.1103	0.0148	0.0882	0.7921	0.8747	0.8314
Maize	phi3	Maize_Query5	0.0212	0.2222	0.0909	0.1333	0.8212	0.899	0.8584
Maize	phi3	Maize_Query6	0.0309	0.4	0.1491	0.2957	0.8214	0.8841	0.8516
Sweet Potato	phi3	Sweet_Potato_Query1	0.0036	0.0873	0.0125	0.0624	0.7735	0.8535	0.8115
Sweet Potato	phi3	Sweet_Potato_Query2	0.024	0.359	0.1244	0.2359	0.858	0.8771	0.8675
Sweet Potato	phi3	Sweet_Potato_Query3	0.0297	0.314	0.084	0.1983	0.8544	0.8489	0.8516
Sweet Potato	phi3	Sweet_Potato_Query4	0.0094	0.152	0.0592	0.0936	0.8037	0.8917	0.8455
Sweet Potato	phi3	Sweet_Potato_Query5	0.0061	0.0914	0.0333	0.0465	0.7735	0.8793	0.823
Ragi	phi3	Ragi_Query1	0.0619	0.2996	0.1244	0.1762	0.8282	0.8953	0.8604
Ragi	phi3	Ragi_Query2	0.0162	0.1188	0.101	0.1188	0.8063	0.8634	0.8339
Ragi	phi3	Ragi_Query3	0.0893	0.5027	0.2431	0.3497	0.8648	0.9365	0.8992
Ragi	phi3	Ragi_Query4	0.0051	0.1197	0.0086	0.0855	0.7926	0.8883	0.8378

Ragi	phi3	Ragi_Query5	0.0577	0.3077	0.2105	0.2564	0.8398	0.9271	0.8813
Ragi	phi3	Ragi_Query6	0.0162	0.2197	0.0585	0.1734	0.811	0.8589	0.8342
Cotton	phi3	Cotton_Query1	0.0189	0.3158	0.0811	0.2632	0.8396	0.9083	0.8726
Cotton	phi3	Cotton_Query2	0.0134	0.2651	0.1481	0.2169	0.8177	0.8742	0.845
Cotton	phi3	Cotton_Query3	0.0096	0.1787	0.0458	0.1103	0.796	0.8878	0.8394
Cotton	phi3	Cotton_Query4	0.0107	0.3784	0	0.2162	0.8569	0.8931	0.8746
Cotton	phi3	Cotton_Query5	0.008	0.1995	0.0477	0.114	0.7963	0.8914	0.8412
Groundnut	phi3	Groundnut_Query1	0.0242	0.2941	0.1	0.2157	0.842	0.8972	0.8687
Groundnut	phi3	Groundnut_Query2	0.0186	0.2778	0.0943	0.1852	0.8166	0.8889	0.8512
Groundnut	phi3	Groundnut_Query3	0.0076	0.1742	0.0382	0.1136	0.8039	0.8538	0.8281
Groundnut	phi3	Groundnut_Query4	0.0115	0.241	0.0244	0.1205	0.8234	0.8663	0.8443
Groundnut	phi3	Groundnut_Query5	0.0059	0.2291	0.0337	0.1229	0.8048	0.8693	0.8358
Maize	qwen2.5	Maize_Query1	0.0117	0.4194	0.1	0.2581	0.8518	0.9153	0.8824
Maize	qwen2.5	Maize_Query2	0.1957	0.6786	0.4815	0.6786	0.9066	0.9375	0.9218
Maize	qwen2.5	Maize_Query3	0.095	0.3813	0.251	0.3268	0.8297	0.9512	0.8863
Maize	qwen2.5	Maize_Query4	0.0068	0.2286	0	0.1143	0.8298	0.8822	0.8552
Maize	qwen2.5	Maize_Query5	0.0356	0.2623	0.1356	0.2295	0.8377	0.894	0.865
Maize	qwen2.5	Maize_Query6	0.106	0.4729	0.2388	0.266	0.8407	0.898	0.8684
Sweet Potato	qwen2.5	Sweet_Potato_Query1	0.0235	0.3714	0.0882	0.2286	0.8334	0.8839	0.8579

Sweet Potato	qwen2.5	Sweet_Potato_Query2	0.1319	0.5429	0.3188	0.4143	0.9024	0.8915	0.8969
Sweet Potato	qwen2.5	Sweet_Potato_Query3	0.0127	0.3619	0.0777	0.1905	0.8769	0.8391	0.8576
Sweet Potato	qwen2.5	Sweet_Potato_Query4	0.2267	0.4478	0.4308	0.4478	0.8627	0.9519	0.9051
Sweet Potato	qwen2.5	Sweet_Potato_Query5	0.0821	0.5556	0.2804	0.4352	0.8443	0.9097	0.8758
Ragi	qwen2.5	Ragi_Query1	0.0816	0.3924	0.1667	0.3038	0.8354	0.9085	0.8704
Ragi	qwen2.5	Ragi_Query2	0.0291	0.3944	0.3478	0.3944	0.8218	0.9024	0.8603
Ragi	qwen2.5	Ragi_Query3	0.045	0.3922	0.1739	0.2824	0.8261	0.9427	0.8805
Ragi	qwen2.5	Ragi_Query4	0.0061	0.1538	0	0.1282	0.8389	0.8879	0.8627
Ragi	qwen2.5	Ragi_Query5	0.7917	0.8966	0.8889	0.8966	0.9357	0.9955	0.9646
Ragi	qwen2.5	Ragi_Query6	0.0221	0.2923	0.0781	0.2308	0.8105	0.8734	0.8408
Cotton	qwen2.5	Cotton_Query1	0.0187	0.3294	0.0964	0.2353	0.8432	0.9064	0.8736
Cotton	qwen2.5	Cotton_Query2	0.0099	0.2162	0.1101	0.1802	0.8044	0.8767	0.839
Cotton	qwen2.5	Cotton_Query3	0.0804	0.3284	0.203	0.2687	0.8113	0.9182	0.8615
Cotton	qwen2.5	Cotton_Query4	0.073	0.3014	0.1806	0.2466	0.8537	0.9447	0.8969
Cotton	qwen2.5	Cotton_Query5	0.0184	0.3243	0.0818	0.2072	0.8423	0.8879	0.8645
Groundnut	qwen2.5	Groundnut_Query1	0.0706	0.3186	0.2162	0.3009	0.85	0.9294	0.8879
Groundnut	qwen2.5	Groundnut_Query2	0.0098	0.2047	0.048	0.126	0.8109	0.8914	0.8493
Groundnut	qwen2.5	Groundnut_Query3	0.0051	0.1974	0.04	0.0921	0.8119	0.843	0.8272

Groundnut	qwen2.5	Groundnut_Query4	0.0233	0.2676	0.0714	0.169	0.8359	0.8708	0.853
Groundnut	qwen2.5	Groundnut_Query5	0.0124	0.2902	0.0524	0.1762	0.8278	0.8576	0.8424

Table S4. Source Attribution and Retrieval Effectiveness Metrics for LLM Responses Across Crops and Queries.

Crop	LLM	Query	Precision@K	Recall@K	MRR	NDCG
Maize	mistral	Maize_Query1	0.3333	0.5	1	1
Maize	mistral	Maize_Query2	0.3333	0.5	1	1
Maize	mistral	Maize_Query3	0.3333	1	1	1
Maize	mistral	Maize_Query4	0.6667	1	1	0.9197
Maize	mistral	Maize_Query5	0.3333	1	1	1
Maize	mistral	Maize_Query6	1	1	1	1
Sweet Potato	mistral	Sweet_Potato_Query1	1	1	1	1
Sweet Potato	mistral	Sweet_Potato_Query2	1	1	1	1
Sweet Potato	mistral	Sweet_Potato_Query3	1	1	1	1
Sweet Potato	mistral	Sweet_Potato_Query4	0.3333	1	1	1
Sweet Potato	mistral	Sweet_Potato_Query5	1	1	1	1
Ragi	mistral	Ragi_Query1	0.6667	1	1	1
Ragi	mistral	Ragi_Query2	0	0	0	0
Ragi	mistral	Ragi_Query3	0.6667	1	1	1
Ragi	mistral	Ragi_Query4	0.3333	0.5	0.3333	0.5
Ragi	mistral	Ragi_Query5	0.3333	1	0.3333	0.5
Ragi	mistral	Ragi_Query6	0.3333	0.5	0.3333	0.5
Cotton	mistral	Cotton_Query1	0.6667	1	1	1
Cotton	mistral	Cotton_Query2	0.6667	1	1	0.9197
Cotton	mistral	Cotton_Query3	0.6667	1	1	1
Cotton	mistral	Cotton_Query4	0.6667	1	1	1
Cotton	mistral	Cotton_Query5	1	1	1	1

Groundnut	mistral	Groundnut_Query1	0.6667	1	1	1
Groundnut	mistral	Groundnut_Query2	0.3333	0.5	1	1
Groundnut	mistral	Groundnut_Query3	0.6667	1	1	0.9197
Groundnut	mistral	Groundnut_Query4	0.6667	1	1	1
Groundnut	mistral	Groundnut_Query5	1	1	1	1
Maize	llama3.1	Maize_Query1	0.3333	0.5	1	1
Maize	llama3.1	Maize_Query2	0.3333	0.5	1	1
Maize	llama3.1	Maize_Query3	0.3333	1	1	1
Maize	llama3.1	Maize_Query4	0.6667	1	1	0.9197
Maize	llama3.1	Maize_Query5	0.3333	1	1	1
Maize	llama3.1	Maize_Query6	1	1	1	1
Sweet Potato	llama3.1	Sweet_Potato_Query1	1	1	1	1
Sweet Potato	llama3.1	Sweet_Potato_Query2	1	1	1	1
Sweet Potato	llama3.1	Sweet_Potato_Query3	1	1	1	1
Sweet Potato	llama3.1	Sweet_Potato_Query4	0.3333	1	1	1
Sweet Potato	llama3.1	Sweet_Potato_Query5	1	1	1	1
Ragi	llama3.1	Ragi_Query1	0.6667	1	1	1
Ragi	llama3.1	Ragi_Query2	0	0	0	0
Ragi	llama3.1	Ragi_Query3	0.6667	1	1	1
Ragi	llama3.1	Ragi_Query4	0.3333	0.5	0.3333	0.5
Ragi	llama3.1	Ragi_Query5	0.3333	1	0.3333	0.5
Ragi	llama3.1	Ragi_Query6	0.3333	0.5	0.3333	0.5
Cotton	llama3.1	Cotton_Query1	0.6667	1	1	1
Cotton	llama3.1	Cotton_Query2	0.6667	1	1	0.9197
Cotton	llama3.1	Cotton_Query3	0.6667	1	1	1

Cotton	llama3.1	Cotton_Query4	0.6667	1	1	1
Cotton	llama3.1	Cotton_Query5	1	1	1	1
Groundnut	llama3.1	Groundnut_Query1	0.6667	1	1	1
Groundnut	llama3.1	Groundnut_Query2	0.3333	0.5	1	1
Groundnut	llama3.1	Groundnut_Query3	0.6667	1	1	0.9197
Groundnut	llama3.1	Groundnut_Query4	0.6667	1	1	1
Groundnut	llama3.1	Groundnut_Query5	1	1	1	1
Maize	phi3	Maize_Query1	0.3333	0.5	1	1
Maize	phi3	Maize_Query2	0.3333	0.5	1	1
Maize	phi3	Maize_Query3	0.3333	1	1	1
Maize	phi3	Maize_Query4	0.6667	1	1	0.9197
Maize	phi3	Maize_Query5	0.3333	1	1	1
Maize	phi3	Maize_Query6	1	1	1	1
Sweet Potato	phi3	Sweet_Potato_Query1	1	1	1	1
Sweet Potato	phi3	Sweet_Potato_Query2	1	1	1	1
Sweet Potato	phi3	Sweet_Potato_Query3	1	1	1	1
Sweet Potato	phi3	Sweet_Potato_Query4	0.3333	1	1	1
Sweet Potato	phi3	Sweet_Potato_Query5	1	1	1	1
Ragi	phi3	Ragi_Query1	0.6667	1	1	1
Ragi	phi3	Ragi_Query2	0	0	0	0
Ragi	phi3	Ragi_Query3	0.6667	1	1	1
Ragi	phi3	Ragi_Query4	0.3333	0.5	0.3333	0.5
Ragi	phi3	Ragi_Query5	0.3333	1	0.3333	0.5
Ragi	phi3	Ragi_Query6	0.3333	0.5	0.3333	0.5
Cotton	phi3	Cotton_Query1	0.6667	1	1	1

Cotton	phi3	Cotton_Query2	0.6667	1	1	0.9197
Cotton	phi3	Cotton_Query3	0.6667	1	1	1
Cotton	phi3	Cotton_Query4	0.6667	1	1	1
Cotton	phi3	Cotton_Query5	1	1	1	1
Groundnut	phi3	Groundnut_Query1	0.6667	1	1	1
Groundnut	phi3	Groundnut_Query2	0.3333	0.5	1	1
Groundnut	phi3	Groundnut_Query3	0.6667	1	1	0.9197
Groundnut	phi3	Groundnut_Query4	0.6667	1	1	1
Groundnut	phi3	Groundnut_Query5	1	1	1	1
Maize	qwen2.5	Maize_Query1	0.3333	0.5	1	1
Maize	qwen2.5	Maize_Query2	0.3333	0.5	1	1
Maize	qwen2.5	Maize_Query3	0.3333	1	1	1
Maize	qwen2.5	Maize_Query4	0.6667	1	1	0.9197
Maize	qwen2.5	Maize_Query5	0.3333	1	1	1
Maize	qwen2.5	Maize_Query6	1	1	1	1
Sweet Potato	qwen2.5	Sweet_Potato_Query1	1	1	1	1
Sweet Potato	qwen2.5	Sweet_Potato_Query2	1	1	1	1
Sweet Potato	qwen2.5	Sweet_Potato_Query3	1	1	1	1
Sweet Potato	qwen2.5	Sweet_Potato_Query4	0.3333	1	1	1
Sweet Potato	qwen2.5	Sweet_Potato_Query5	1	1	1	1
Ragi	qwen2.5	Ragi_Query1	0.6667	1	1	1
Ragi	qwen2.5	Ragi_Query2	0	0	0	0
Ragi	qwen2.5	Ragi_Query3	0.6667	1	1	1
Ragi	qwen2.5	Ragi_Query4	0.3333	0.5	0.3333	0.5
Ragi	qwen2.5	Ragi_Query5	0.3333	1	0.3333	0.5

Ragi	qwen2.5	Ragi_Query6	0.3333	0.5	0.3333	0.5
Cotton	qwen2.5	Cotton_Query1	0.6667	1	1	1
Cotton	qwen2.5	Cotton_Query2	0.6667	1	1	0.9197
Cotton	qwen2.5	Cotton_Query3	0.6667	1	1	1
Cotton	qwen2.5	Cotton_Query4	0.6667	1	1	1
Cotton	qwen2.5	Cotton_Query5	1	1	1	1
Groundnut	qwen2.5	Groundnut_Query1	0.6667	1	1	1
Groundnut	qwen2.5	Groundnut_Query2	0.3333	0.5	1	1
Groundnut	qwen2.5	Groundnut_Query3	0.6667	1	1	0.9197
Groundnut	qwen2.5	Groundnut_Query4	0.6667	1	1	1
Groundnut	qwen2.5	Groundnut_Query5	1	1	1	1

Table S5. Semantic Similarity and Source Attribution Scores for LLM Responses Across Crops and Queries

Crop	LLM	Query	Semantic_Similarity	Attribution
Maize	mistral	Maize_Query1	0.9255	0.3333
Maize	mistral	Maize_Query2	0.6408	0.6667
Maize	mistral	Maize_Query3	0.7604	1
Maize	mistral	Maize_Query4	0.6554	0.3333
Maize	mistral	Maize_Query5	0.6016	0.6667
Maize	mistral	Maize_Query6	0.6407	0.6667
Sweet Potato	mistral	Sweet_Potato_Query1	0.872	0.6667
Sweet Potato	mistral	Sweet_Potato_Query2	0.8323	0.3333
Sweet Potato	mistral	Sweet_Potato_Query3	0.87	0.3333
Sweet Potato	mistral	Sweet_Potato_Query4	0.6027	0.3333
Sweet Potato	mistral	Sweet_Potato_Query5	0.8479	1
Ragi	mistral	Ragi_Query1	0.8756	0.6667
Ragi	mistral	Ragi_Query2	0.4861	0.3333
Ragi	mistral	Ragi_Query3	0.8448	1

Ragi	mistral	Ragi_Query4	0.5752	0.3333
Ragi	mistral	Ragi_Query5	0.746	0.3333
Ragi	mistral	Ragi_Query6	0.5501	0.3333
Cotton	mistral	Cotton_Query1	0.7466	0.3333
Cotton	mistral	Cotton_Query2	0.9113	0.6667
Cotton	mistral	Cotton_Query3	0.8652	1
Cotton	mistral	Cotton_Query4	0.8966	0.6667
Cotton	mistral	Cotton_Query5	0.7648	1
Groundnut	mistral	Groundnut_Query1	0.9586	0.3333
Groundnut	mistral	Groundnut_Query2	0.6284	0.6667
Groundnut	mistral	Groundnut_Query3	0.6195	0.6667
Groundnut	mistral	Groundnut_Query4	0.8066	0.3333
Groundnut	mistral	Groundnut_Query5	0.6057	0.6667
Maize	llama3.1	Maize_Query1	0.863	0.3333
Maize	llama3.1	Maize_Query2	0.6931	0.6667
Maize	llama3.1	Maize_Query3	0.8761	0.6667
Maize	llama3.1	Maize_Query4	0.6039	0.3333
Maize	llama3.1	Maize_Query5	0.6185	1
Maize	llama3.1	Maize_Query6	0.6296	1
Sweet Potato	llama3.1	Sweet_Potato_Query1	0.851	0.3333
Sweet Potato	llama3.1	Sweet_Potato_Query2	0.7967	0.3333
Sweet Potato	llama3.1	Sweet_Potato_Query3	0.8494	1
Sweet Potato	llama3.1	Sweet_Potato_Query4	0.6669	0.6667
Sweet Potato	llama3.1	Sweet_Potato_Query5	0.8457	0.6667
Ragi	llama3.1	Ragi_Query1	0.9346	1
Ragi	llama3.1	Ragi_Query2	0.2595	0.6667
Ragi	llama3.1	Ragi_Query3	0.8925	1
Ragi	llama3.1	Ragi_Query4	0.5976	0.3333
Ragi	llama3.1	Ragi_Query5	0.6484	0.6667
Ragi	llama3.1	Ragi_Query6	0.4809	0.3333
Cotton	llama3.1	Cotton_Query1	0.8089	1

Cotton	llama3.1	Cotton_Query2	0.8526	0.6667
Cotton	llama3.1	Cotton_Query3	0.8955	0.3333
Cotton	llama3.1	Cotton_Query4	0.8329	0.6667
Cotton	llama3.1	Cotton_Query5	0.7477	0.6667
Groundnut	llama3.1	Groundnut_Query1	0.7383	0.6667
Groundnut	llama3.1	Groundnut_Query2	0.6766	0.6667
Groundnut	llama3.1	Groundnut_Query3	0.6895	0.3333
Groundnut	llama3.1	Groundnut_Query4	0.7843	0.6667
Groundnut	llama3.1	Groundnut_Query5	0.6532	0.6667
Maize	phi3	Maize_Query1	0.8957	0.6667
Maize	phi3	Maize_Query2	0.7955	0.6667
Maize	phi3	Maize_Query3	0.7961	1
Maize	phi3	Maize_Query4	0.6129	0.6667
Maize	phi3	Maize_Query5	0.5796	0.3333
Maize	phi3	Maize_Query6	0.7496	1
Sweet Potato	phi3	Sweet_Potato_Query1	0.7445	0.6667
Sweet Potato	phi3	Sweet_Potato_Query2	0.8208	0.3333
Sweet Potato	phi3	Sweet_Potato_Query3	0.889	0.6667
Sweet Potato	phi3	Sweet_Potato_Query4	0.4787	0.3333
Sweet Potato	phi3	Sweet_Potato_Query5	0.7685	1
Ragi	phi3	Ragi_Query1	0.8336	0.6667
Ragi	phi3	Ragi_Query2	0.148	1
Ragi	phi3	Ragi_Query3	0.8942	0.6667
Ragi	phi3	Ragi_Query4	0.6681	0.6667
Ragi	phi3	Ragi_Query5	0.7548	0.3333
Ragi	phi3	Ragi_Query6	0.6078	0.3333
Cotton	phi3	Cotton_Query1	0.8902	0.6667
Cotton	phi3	Cotton_Query2	0.727	1
Cotton	phi3	Cotton_Query3	0.7846	0.6667
Cotton	phi3	Cotton_Query4	0.8254	0.3333
Cotton	phi3	Cotton_Query5	0.7497	1

Groundnut	phi3	Groundnut_Query1	0.9092	0.6667
Groundnut	phi3	Groundnut_Query2	0.6403	1
Groundnut	phi3	Groundnut_Query3	0.7563	0.6667
Groundnut	phi3	Groundnut_Query4	0.7374	0.6667
Groundnut	phi3	Groundnut_Query5	0.7203	1
Maize	qwen2.5	Maize_Query1	0.8547	0.3333
Maize	qwen2.5	Maize_Query2	0.82	0.6667
Maize	qwen2.5	Maize_Query3	0.7983	1
Maize	qwen2.5	Maize_Query4	0.6958	0.3333
Maize	qwen2.5	Maize_Query5	0.5771	0.6667
Maize	qwen2.5	Maize_Query6	0.8131	1
Sweet Potato	qwen2.5	Sweet_Potato_Query1	0.8915	0.6667
Sweet Potato	qwen2.5	Sweet_Potato_Query2	0.8888	0.3333
Sweet Potato	qwen2.5	Sweet_Potato_Query3	0.8336	0.3333
Sweet Potato	qwen2.5	Sweet_Potato_Query4	0.6685	0.3333
Sweet Potato	qwen2.5	Sweet_Potato_Query5	0.8805	1
Ragi	qwen2.5	Ragi_Query1	0.9326	0.6667
Ragi	qwen2.5	Ragi_Query2	0.2779	0.6667
Ragi	qwen2.5	Ragi_Query3	0.9164	1
Ragi	qwen2.5	Ragi_Query4	0.6316	0.3333
Ragi	qwen2.5	Ragi_Query5	0.9927	0.3333
Ragi	qwen2.5	Ragi_Query6	0.4489	0.3333
Cotton	qwen2.5	Cotton_Query1	0.8831	0.6667
Cotton	qwen2.5	Cotton_Query2	0.7777	1
Cotton	qwen2.5	Cotton_Query3	0.6603	1
Cotton	qwen2.5	Cotton_Query4	0.9176	0.6667
Cotton	qwen2.5	Cotton_Query5	0.7616	0.6667
Groundnut	qwen2.5	Groundnut_Query1	0.933	0.6667
Groundnut	qwen2.5	Groundnut_Query2	0.5849	0.6667
Groundnut	qwen2.5	Groundnut_Query3	0.6464	0.6667
Groundnut	qwen2.5	Groundnut_Query4	0.757	0.6667

Groundnut	qwen2.5	Groundnut_Query5	0.7112	0.3333
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