PAHLE INDIA FOUNDATION
FACILITATING POLICY CHANGE

Research Paper on Used Cooking Oil (UCO) Based Biodiesel

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List of Abbreviations

BDAI	Biodiesel Association of India
CAGR	Compound Aggregate Growth Rate
DTU	Technical University of Denmark
EOI	Expression of Interest
EU	European Union
FAO	Food and Agriculture Organization (United Nations)
FBO	Food Business Operators
FICCI	Federation of Indian Chambers of Commerce & Industry
FMCG	Fast-Moving Consumer Goods
FSSAI	Food Safety and Standards Authority of India
GBP	British Pound Sterling
HRAAC	Hotel & Restaurant Approval and Classification Committee
INR	The Indian Rupee
IOCL	Indian Oil Corporation Limited
MoP&NG	Ministry of Petroleum and Natural Gas
MT	Metric Tonnes
NBM	National Biodiesel Mission
NRAI	National Restaurants' Association of India's
OECD	Organisation for Economic Co-operation and Development
PIF	Pahle India Foundation
PNPB	Brazil's National Biodiesel Production Program
PPAC	Petroleum Planning and Analysis Cell
PwC	PricewaterhouseCoopers Pvt. Ltd.
RUCO	Repurpose Used Cooking Oil
SEA	Solvent Extractors' Association
TPC	Total Polar Compounds
UCO	Used Cooking Oil
UNEP	United Nations Environment Programme
USD	United States Dollar
USDA	United States Department of Agriculture
WVO	Waste Vegetable Oil

1. Introduction

1.1 The Global and Indian Biodiesel Scenario

It was from 2015 onwards that the global policy focus shifted towards augmenting production of biofuels, as the use of conventional fuels continued to rise and concerns over climate change and the environment came to the fore. In order to address both issues, that is to meet the growing demand for fuel (specifically in the transport sector) as well as to ensure that fuel used was more environment friendly, biofuels have been taken up as an alternative to conventional fuels. The aim is to use biofuels either by blending with petrol and diesel, or by themselves in order to reduce dependence on conventional fuels.

Biodiesel is one of the biofuels that has shown potential for greater use and applicability, evinced by the growth in its production and use over the past decade. Globally, biodiesel production has gone from 840 million litres in 2000 to 36.1 billion litres in 2017 (refer Table 1.1).

Table 1.1: Global Production of Biodiesel (in billion litres)[1]

Year	Volume of Production
2000	0.84
2005	3.66
2010	19.9
2015	30.0
2016	33.9
2017	36.1

Biodiesel is largely produced from oilseeds (both edible and non-edible) such as rapeseed or soybean, through a process called transesterification. South America and Europe were the largest producers of biodiesel as of 2017, accounting for 37 per cent and 44 per cent of global production respectively (refer Table 1.2). Asia's contribution to global production was just under 20 per cent, and India's contribution to global biodiesel production was less than 1 per cent.

[1] International Energy Agency, 2019.

1.2 Global Pricing and Blending Mandates:

In terms of pricing, global prices for biodiesel stood at approximately USD 2.35 per gallon (or USD 0.6 per litre) in early 2020[2], up from approximately USD 1.8 per gallon (or USD 0.5 per litre) in August 2019.[3] Based on a separate Platts market scan, the actual biodiesel prices from 2010 onwards even for European markets (such as in the United Kingdom) stood at GBP 0.61 per litre (or USD 0.7 per litre).[4] The OECD-FAO Agricultural Outlook report for the period 2020-2029, states that prices of biodiesel feedstock and biodiesel itself would remain somewhere in the range of USD 60 – 80 per hectolitre(s) and USD 80 per hectolitre(s), respectively.[5] That is in the 2020-2029 decade, the price of biodiesel feedstock and by extension biodiesel itself is projected to remain steady around USD 0.5-0.6 per litre. This is equivalent to INR 37 – 44 per litre (at current exchange rates). The comparatively lower prices of biodiesel in these countries is owing to their high blending percentages, and widespread plants and production capacities.

There are several nations in the world that have blending mandates for biofuels. In terms of blending mandates for biodiesel, Europe, US, Brazil, and China all have their own policies on blend percentages. For example, Brazil's National Biodiesel Production Program (PNPB) has been in place since 2004, with a blending mandate that began at 2 per cent in 2008, and has risen over the years to be set at 10 per cent for 2019, with legislation being pursued to push blending to 15 per cent in the near future.[6] 27 of Europe's nations, known as the EU-27 have a regional blending mandate of 20 per cent since late 2016.[7] In the Asia-Pacific, China has a mandate for 15 per cent blending by 2020, and a plan to increase blend percentages further. Each nation's blend percentages and mandates on biofuels are determined through stakeholder consultation, and legislative lobbying. In some cases like that of the US, producing states determine blending mandates – which creates some dissonance at the national level, but helps them maintain progress towards meeting their biofuel policy goals.

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[2] Alternative Fuels Data Centre, US Department of Energy, July 2020. https://afdc.energy.gov/fuels/prices.html

[3] 'Weekly Global Biodiesel Report', S&P Global Platts, 28th August 2019.

[4] Chris Charles, 'A Review of Projected Biofuel Prices for the United Kingdom', Global Subsidies Initiative, International Institute for Sustainable Development, May 2013. https://www.iisd.org/gsi/sites/default/files/bf_uk_fqdmodel.pdf

[5] *OECD-FAO Agricultural Outlook 2020-2029*, FAO, Rome/OECD Publishing (Paris), https://doi.org/10.1787/1112c23b-en : pg. 199.

[6] 'Biofuel Mandates Around the World 2018', Jim Lane, *Biofuels Digest*, 1st January 2018. https://www.biofuelsdigest.com/bdigest/2018/01/01/biofuels-mandates-around-the-world-2018/5/

[7] *Ibid*.

Table 1.2: Production of Biodiesel by Regions (in billion litres)[8]

Continent	Volume of Production
Africa	0.00
Americas	13.2
Asia	7.18
Europe	15.8
Oceania	0.00
World	36.1

1.3 India's Biodiesel Demand and Blend Percentage

India's National Biodiesel Mission (NBM) was established in December 2009, when the policy debate over the viability of biofuels as alternative fuels for the transport sector had begun to gain traction. The NBM identified jatropha as a desirable oilseed from which biodiesel could be produced, in order to meet the target of 20 per cent blending by 2017. In India, the old biofuels policies stipulated that biofuels are only to be produced from non-edible feedstocks, in the interest of maintaining food security. Therefore, the major feedstocks for biodiesel in India were non-edible oilseeds like jatropha and pongamia.[9] However, biodiesel is also produced from second generation sources, such as used cooking oil (UCO) and animal fats.

Jatropha cultivation and harvesting was initially encouraged under the NBM, however several factors including an acute shortage of seeds and lack of availability of land for cultivation of jatropha, led to the plan for biodiesel production from such oilseeds not providing desired outcomes.[10] The biodiesel demand estimates drawn up in studies at the time showed that the land requirement, and on ground availability fell well short of the mark (refer Table 1.3).

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8 *OECD-FAO Agricultural Outlook 2020-2029*, FAO, Rome/OECD Publishing (Paris), https://doi.org/10.1787/1112c23b-en : pg. 199.

9 'Biofuels in India: Future Challenges', P. Shinoj, S.S. Raju, et al. Policy Brief, National Centre for Agricultural Economics and Policy Research, May 2011: pg. 1.

10 *Ibid*: pg. 2.

Table 1.3: Biodiesel Demand and Jatropha Area Required to Meet Blending Target[11]

Year	Diesel Demand	At 5% blending		At 10% blending		At 20% blending	
		Biodiesel Demand (from Jatropha)	*Required Area for Cultivation*	*Biodiesel Demand (from Jatropha)*	*Required Area under Cultivation*	*Demand*	*Required Area under Cultivation*
2011-12	64.19	3.21	3.42	6.42	6.85	12.84	13.69
2016-17	92.15	4.61	4.91	9.21	9.83	18.43	19.66
2020-21	123.06	6.15	6.56	12.31	13.13	24.61	26.25

Note: Demand in million tonnes, Area in million ha.

Given the constraints for jatropha cultivation, it became important to explore and take up varied and alternative feedstocks for biodiesel. However, before exploring the viability of alternate feedstocks, estimated demand for diesel, production levels of biodiesel in India and the prospect of achieving 5 per cent blending by 2030 (as per the National Biofuels Policy, 2018) need to be analysed. The Ministry of Petroleum and Natural Gas' (MoP&NG) latest Annual Report (2018-19) stated that 82 million litres (8.2 crore litres) of biodiesel was procured by oil manufacturing companies (OMCs) as of November 2018.[12] This figure accounts for just over 50 per cent of the production volume of biodiesel in 2018 (refer Table 1.4).

Table 1.4: Production Volumes of Biodiesel in India (in million litres)[13]

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Production	100	111	126	132	138	152	158	170	185	190

In order to determine prospect for blending, the production of biodiesel has to be balanced against overall diesel demand and current blend percentage. The demand for diesel in India has grown by over 30 per cent since 2010 (refer Table 1.5).

[11] *Ibid*: pg. 3.

[12] 'Energising and Empowering India: Annual Report 2018-19', Ministry of Petroleum and Natural Gas, Government of India, 2019: pg. 22. http://petroleum.nic.in/sites/default/files/AR_2018-19.pdf

[13] 'India – Biofuels Annual 2019', Amit Aradhey, Global Agricultural Information Network Report, USDA, February 2019: pg. 20. https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Biofuels%20Annual_New%20Delhi_India_8-9-2019.pdf

Table 1.5: Diesel Use in India (in million litres)[14]

Year	Diesel (On-road)	Diesel (Total use)
2010	42,625	71,041
2011	45,520	75,866
2012	49,343	82,238
2013	49,354	82,256
2014	49,605	82,674
2015	52,239	87,064
2016	55,179	91,965
2017	57,025	95,041
2018	61,247	102,079
2019	63,771	106,285

The 'On-road' category covers diesel use in the transport sector. There are other sectors such as agriculture, construction, railways, shipping, and industry where diesel is used. However, the combined demand and use of diesel in these sectors amounts to barely 50 per cent of the use in the transport sector. This is therefore the main sector that will gain from increased blending, and use of biodiesel. It is, however, more pertinent to analyse whether current production volumes of biodiesel are growing in order to meet target blend percentages.

Table 1.6: Biodiesel Blend Percentage[15]

Year	Diesel (on road)	Biodiesel (on road)	Blend (%)
2010	42,625	36	0.09
2011	45,520	31	0.07
2012	49,343	42	0.08
2013	49,354	49	0.10
2014	49,605	32	0.06
2015	52,239	41	0.08
2016	55,179	48	0.09
2017	57,025	72	0.13
2018	61,247	83	0.14
2019	62,284	85	0.14

Given the current blend percentage of 0.14 per cent (refer Table 1.6), it is evident that India's biodiesel production will have to increase ten-fold in order to begin inching towards the target of 5 per cent blending by 2030. The good news is that this has been

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[14] Petroleum Planning and Analysis Cell (PPAC), Government of India, 2019.

[15] *Ibid.*

identified at the beginning of this decade, and therefore allows some time to put in place measures for building production capacity in biodiesel.

1.4 Alternative Feedstock for Biodiesel

Second and third generation feedstocks such as used cooking oil (UCO) and animal fats or tallow, are some of the alternative feedstocks for biodiesel manufacture. Among these two, UCO is the feedstock whose collection can be scaled up, to boost biodiesel production figures. UCO is edible, vegetable oil left over after consumption. Therefore, total vegetable oil consumed in India becomes the first variable to examine. As of 2020, based on per capita consumption of edible oil, total vegetable oil demand in India stood at 25 million metric tonnes (MT).[16] A Rabobank report (2018) on the Indian edible oil industry, projected that India's vegetable oil demand would increase at a rate of 3 per cent to stand at 34 million MT in 2030.[17]

Given the projected demand for edible oil in India, the UCO potential of the same can be calculated. This is because, in the course of the research conducted for this paper the factor of conversion of edible oil to UCO was found to be 0.15. That is, in most cases of consumption 15 per cent of the edible oil consumed was left over as UCO. The factor of conversion of UCO to biodiesel was determined as 0.9. That is, over 90 per cent of the volume of UCO is converted to biodiesel in the manufacturing process. With these factors of conversion, and the current and projected demand for edible oil in hand, we calculated potential UCO collection and consequently biodiesel produced from the same. The target of collecting 220 crore litres of biodiesel manufactured from UCO by 2030, is used for calculating required percentage of recovery. These calculations factor in zero-loss or ideal collection and recovery processes.

Table 1.7: Edible Oil Demand, UCO and Biodiesel Potential[18]

	Current (2020)	Projected (2030)
Edible Oil Demand (in million MT)	25	34
Edible Oil Demand (in crore litres)	2,750	3,695
UCO Potential from Edible Oil (in crore litres)	412.5	554.25
Biodiesel Potential from UCO (in crore litres)	371.25	498.83
Percentage of recovery required	59	44

[16] Rajya Sabha Unstarred Question No. 708, 7th February 2020. https://commerce.gov.in/writereaddata/UploadedFile/MOC_637166782599628854_RS-07-02-2020.pdf

[17] "The Future of India's Edible Oil Industry – How will India's vegetable oil demand shape up by 2030?" Rohit Dhanda, *Rabobank*, June 2018. https://research.rabobank.com/far/en/sectors/grains-oilseeds/The-Future-of-India-s-Edible-Oil-Industry.html

[18] Refer footnotes 10 and 11.

It is clear that in order to meet the target of collecting 220 crore litres of biodiesel manufactured from UCO, at least 59 per cent of current, and 44 per cent of projected biodiesel potential needs to be capitalised on. This is given an ideal scenario, where every last drop of UCO available is collected and converted to biodiesel. The following chapter will therefore explore the on-ground availability and viability of UCO as a feedstock for biodiesel.

2. Used Cooking Oil (UCO) as a Feedstock

2.1 Used Cooking Oil (UCO) and Biodiesel Production

As a result of the failure of jatropha in meeting biodiesel production requirements, most production plants in India switched to multiple feedstocks and relevant technologies for biodiesel production. As of the end of 2018, there were 6 biodiesel plants in India with a total production capacity of 650 million litres (refer Table 2.1). A more realistic appraisal was provided by Purohit and Dhar (2015), whose study identified that 20 biodiesel plants in India produced 140 to 300 million litres (14 to 30 crore litres) of biodiesel between 2012 and 2015.[19]

Table 2.1: Production Plants and Capacity (in million litres)[20]

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of Plants	5	5	5	6	6	6	6	6	6	6
Production Capacity	450	450	460	465	480	500	550	600	650	660
Capacity Use (%)	22.2	24.7	27.4	28.4	28.8	30.4	28.7	28.3	28.5	28.8

OMCs like Indian Oil Corporation Limited (IOCL) put out an Expression of Interest (EOI) in early 2019, for third parties willing to set up biodiesel production plants in various states of India. The list of upcoming and planned plants, and their locations is given in Appendix B. As mentioned previously, multiple feedstocks are used for biodiesel production. However, there are varying levels of feedstocks being used to produce biodiesel, with 'Non-Edible Industrial Veg Oil' and 'Used Cooking Oil' accounting for close to 95 per cent of feedstock used (refer Table 2.2). As of 2019, the production of biodiesel from all feedstocks, stood at 180,000 MT (refer Table 2.2) or just over 190 million litres (19 crore litres).

The production of biodiesel from UCO alone stood at 65,000 MT (refer Table 2.2) or 7 million litres (7 crore litres). Compared to the current UCO and biodiesel potential (refer Table 1.7), this is just under a mere 2 per cent of the total potential, and only a meagre 3 per cent of the target 220 crore litres required by 2030. This outlines the research question that this paper seeks to address. Can India increase levels of

[19] 'Promoting Low Carbon Transport in India: Biofuel Roadmap for India' Pallav Purohit and Subhash Dhar, UNEP – DTU Partnership, November 2015: pg. 9.

[20] 'India – Biofuels Annual 2019', Amit Aradhey, Global Agricultural Information Network Report, USDA, February 2019: pg. 20. https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Biofuels%20Annual_New%20Delhi_India_8-9-2019.pdf

biodiesel produced from UCO, from the current 2 per cent of total potential to at least 44 per cent of the projected total potential in the next 10 years? If not, to what extent can UCO collection and its conversion to biodiesel be increased over the next decade? That is, if not 44 per cent, to what extent can India boost UCO collection in order to meet its target volumes for blending by 2030.

Table 2.2: Existing Biodiesel Plants – List[21]

Sr. No.	Company/Plant Name	City	State	Annual Production
1	Kaleesuwari Refinery Pvt. Ltd.	--	Andhra Pradesh	--
2	Bio Max	Vishakhapatnam	Andhra Pradesh	156,000 tonnes
3	Emami Biotech Pvt. Ltd.	Haldia	West Bengal	48,000 – 60,000 tonnes
4	Universal Biofuels	Kakinada	Andhra Pradesh	36,000 – 48,000 tonnes
5	CREDA	Raipur	Chhattisgarh	--
6	Khanda Biofuels Pvt. Ltd.	Hyderabad	Telangana	--
7	Yantra Fintech Ltd.	Chennai	Tamil Nadu	12,000 tonnes
8	Yamuna Bio Industries Ltd.	Vadodara	Gujarat	--
9	Unicon Fibro Chem Ltd.	Silvassa	Daman & Diu	--
10	Rajputana Biofuels Ltd.	Jaipur	Rajasthan	--
11	Kotiar Biofuels Ltd.	--	Rajasthan	--
12	Wash Well	Bhilwara	Rajasthan	--
13	Kissan Agro Industries Ltd.	Noida	Uttar Pradesh	6,000 tonnes
14	Monopoly Industries Ltd.	Khopoli	Maharashtra	--
15	Eco Green Fuels Pvt. Ltd.	Bangalore	Karnataka	--
16	BioD Industries Ltd.	Bawal	Haryana	6,000 tonnes
17	Munzer Bharat	Mumbai	Maharashtra	--
18	Global	Panvel	Maharashtra	--
19	Al Noor	Muzaffarnagar	Uttar Pradesh	--
20	Elite Oil Ltd.	Kakinada	Andhra Pradesh	--
21	Southern Biotech Ltd.	--	Andhra Pradesh	--
22	Southern Biotech Ltd.	--	Andhra Pradesh	--
23	Nova Biofuels Pvt. Ltd.	--	Haryana	--
24	Ruchi (Pilot Plant)	--	Gujarat	--
25	RIL (Pilot Plant)	--	Andhra Pradesh	--
26	Costal Energy	--	West Bengal	--

[21] 'Biodiesel Plant List', The Biodiesel Association of India (BDAI). https://www.bdai.org.in/bioplant.php

Table 2.2 provides a summary of the 26 biodiesel production plants currently registered with the Biodiesel Association of India (BDAI). It is clear that almost 95 per cent of the biodiesel produced in India comes from just 5 or 6 production plants in the country (as corroborated by the BDAI). There is little to no data available in the public domain about feedstock-wise stratification of the biodiesel produced by these plants. While the highest production capacity is that of Biomax, there are other plants such as Universal and Emami Biotech which produce upto 50 – 60,000 tonnes each. Apart from the top 5 or 6, the remaining production plants have a combined annual production capacity of approximately 12,000 tonnes. It has to be noted here that plants rarely run at 100 per cent of their production capacity, in fact production is often dependent on procurement of raw materials (palm stearin, tallow, UCO).

While Table 2.3 provides feedstock-wise biodiesel production from the three main feedstocks – palm stearin (industrial vegetable oil), UCO, and animal fats and tallow, biodiesel can also be produced from tree-borne oils and acid oils. While there is no known production of biodiesel from tree-borne oils, biodiesel produced from acid oils has only amount to 12,000 – 18,000 MT annually (from just one biodiesel plant) over the past few years. There is no disaggregated data available on biodiesel production from either of these sources over an extended period of time.

Table 2.3: Feedstock-wise Biodiesel Production (in thousand MT)[22]

Feedstock/Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Non-Edible Industrial Veg Oil	50	58	65	70	75	85	90	100 (10.85)	110 (11.95)	105 (11.41)*
Used Cooking Oil	38	42	48	49	50	55	55	55 (5.97)	60 (6.52)	65 (7.06)*
Animal Fats and Tallow	6	6	7	7	6	5	6	6 (0.65)	8 (0.87)	10 (1.08)*
Total	94	98	120	126	131	145	151	161	178	180

**Note: Figures in parentheses are in crore litres.*

The use of biodiesel in the transport sector is largely through blending. The prevailing blend percentage is calculated by comparing the biodiesel used 'on road' and the diesel used 'on road'. Over the past decade, there has been a meagre uptick in blend percentage from 0.09 in 2010 to 0.14 in 2019 (refer Table 1.6).

The study by Purohit and Dhar (2015), under the aegis of the United Nations Environment Programme (UNEP), identified that there is sizeable production of ethanol and biodiesel in India through first generation (1G) pathways, or directly from crops. However, the volume of production is not nearly enough to meet blending

[22] *Ibid*.

targets for 2030. Even if second generation pathways, that is production from crop residue and biomass conversion are pursued, a total of 5 billion (500 crore) litres of biodiesel will be produced which is barely enough to meet 3 per cent of biodiesel demand by 2030.[23]

Since first and second generation pathways of biodiesel production clearly do not help meet the 5 per cent blending target by 2030, it is necessary to look at boosting other feedstocks for biodiesel production. While palm stearin and tallow are two other feedstocks for biodiesel production, they are heavily import-dependent and are expensive as a result. This would not only restrict their availability, but also impact the final price of biodiesel produced from them. In the case of UCO, its raw material is edible oil which is primarily used for food. As a result, even though edible oil is imported, it is an import that will rarely be adversely affected given that it is an input for food – a primary need.

It has already been noted previously that UCO is a major feedstock for biodiesel production. It also happens to be a feedstock that has remained largely unregulated, and untraced, until recently. The MoP&NG and Food Safety and Standards Authority of India (FSSAI) introduced the Repurpose Used Cooking Oil (RUCO) initiative in early 2018. FSSAI clearly stated in its background note on UCO that it poses significant health risks, and was therefore to be regulated in terms of limiting number of uses of cooking oil.[24]

FSSAI also took cognisance of the fact that the UCO ecosystem in India is largely unregulated. This leads to UCO from organised Food Business Operators (FBOs) finding its way to smaller restaurants, dhabas, and road-side vendors or hawkers.[25] It also noted that UCO disposal was handled in potentially environmentally hazardous ways. Given that UCO is a feedstock for biodiesel production, it was recognised that diverting UCO towards UCO aggregators and biodiesel manufacturers was perhaps better than letting it be sold unregulated, and choking sewage and polluting water. The FSSAI estimates that 23 million metric tonnes (MT) of cooking vegetable oil is consumed across the country, of which 3 million MT could be recovered in the form of UCO and diverted towards the production of biodiesel.

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[23] 'Promoting Low Carbon Transport in India: Biofuel Roadmap for India' Pallav Purohit and Subhash Dhar, UNEP – DTU Partnership, November 2015: pg. 24.

[24] 'Background Note on Used Cooking Oil', FSSAI, Government of India, June 2018.

[25] *Ibid*.

The total edible oil demand in India as of 2020, stands at approximately 25 million MT or 2,750 crore litres.[26] Less than half this demand is met domestically. That is, only 10.50 million MT is produced from primary (rapeseed and mustard, groundnut, sunflower, soybean, and safflower) and secondary (oil palm, coconut, rice bran, cotton seed, and tree-borne oilseeds) sources. The remaining demand of 14.50 million MT is met through imports. This is corroborated by the figures related to India's edible oil imports, which put total imports of edible oil in 2018-19 at 13 million MT.[27] Currently, India imports just under 15 million MT of edible oil, according to the Solvent Extractors' Association (SEA) of India.[28]

India is among the top importers of edible oil in the world after China, with well over half of India's edible oil needs being met through imports. This is despite having a significant area of land under oilseed cultivation.[29] India's top imports of edible oils have been palm oil, sunflower oil, and soybean oil. However, India's consumption, and consequently imports of all kinds of edible oil have been adversely impacted during the national lockdown period.[30] Palm oil is used more extensively in the food service industry, whereas sunflower, soybean, peanut, and sesame oils are used by households.[31]

While imports dominate the Indian edible oil market, it is important to consider them in the overall UCO estimate calculations, as imports will also contribute to cooking oil left over from both commercial and household use. The National Biofuels Policy 2018 set the target of achieving 5 per cent biodiesel blending by 2030. The total volume of biodiesel required for achieving this target has been quoted as 600 crore litres (6,00,00,00,000 litres). However, as a part of achieving the blending target for 2030, it is presumed that UCO will serve as one of three feedstocks for biodiesel production.

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[26] Rajya Sabha Unstarred Question No. 708, 7th February 2020. https://commerce.gov.in/writereaddata/UploadedFile/MOC_637166782599628854_RS-07-02-2020.pdf

[27] US Department of Agriculture, 2019.

[28] 'India plans to hike edible oil import taxes to boost local supply, sources say', *Economic Times*, 8th June 2020. https://economictimes.indiatimes.com/news/economy/foreign-trade/india-plans-to-hike-edible-oil-import-taxes-to-boost-local-supply-sources-say/articleshow/76266851.cms?from=mdr

[29] G. Govindaraj et al. 'Dynamics of Household Edible Oil Consumption in Rural and Urban Tamil Nadu', presented at International Association of Agricultural Economists Triennial Conference, August 2012: pg. 3.

[30] 'India's vegetable oil demand set to drop for the first time in decades', *The Economic Times*, 30th March 2020. https://economictimes.indiatimes.com/markets/commodities/news/indias-vegetable-oil-demand-set-to-drop-for-first-time-in-decades/articleshow/74885061.cms?from=mdr

[31] 'Indian households shun downmarket palm oil, cutting demand in lockdown', Rajendra Jadhav and Mei Mei Chu, *Reuters*, 7th July 2020. https://in.reuters.com/article/india-palmoil-imports/indian-households-shun-downmarket-palm-oil-cutting-demand-in-lockdown-idINKBN2480ZM

Therefore, at the rate of meeting one-third of the target, volume of biodiesel produced from UCO must be at least 220 crore litres (2,20,00,00,000 litres). In an ideal scenario, this volume requirement could assuredly be met from the 412.5 crore litres of UCO potentially available (refer section 1.3). UCO's viability and preference as a feedstock for biodiesel production will be discussed in further detail in Section 2.2. Whereas, the UCO market - its sources and supply chain, and collection estimates based on varied scenarios will be elaborated on in Chapters 3 and 4, respectively.

2.2 UCO Aggregation, Collection, and Procurement

UCO is available from two main sources – food service industry (commercial) and households (retail). While UCO is available primarily from FBOs, some may be collected from households as well. There is one more stakeholder that gets added to the UCO supply and value chain at the collection and aggregation stage - UCO aggregators, who largely operate as independent agencies.

Interactions with biodiesel manufacturers brought forward certain important points with regard to the UCO aggregation, collection and procurement process. (A brief outline of the process of production of biodiesel from UCO is provided in Appendix A.) The most prominent point was that there is no organised channel for UCO – not only in terms of its collection, aggregation and procurement, but also in terms of communicating with various government departments and agencies. In fact, it was also emphasised that there have been no clear guidelines on most procedures, whether related to registering with FSSAI, providing certificates of UCO collection, or even about the implementation of the RUCO initiative. The lack of clear demarcation of functions of OMCs, FSSAI, MoP&NG, and other involved government departments makes the entire process a tedious one for most biodiesel manufacturers and UCO aggregators.

Collection of UCO from FBOs or any other source depends on volume. If the volume of UCO to be collected is large, then the biodiesel manufacturers will collect the same directly from its source. However, wherever the volume of UCO to be collected is below a certain threshold (usually below 100-150 litres), the collection is handled by UCO aggregators. In most cases, the UCO aggregators are contracted by biodiesel manufacturers to collect smaller quantities of UCO.

In terms of procurement, both manufacturers and aggregators are aware that the sale of UCO is not prohibited in any manner. The RUCO initiative was a welcome move, in so far as FBOs began approaching biodiesel manufacturers to find out about giving their UCO to them. However, the number of FBOs that took the initiative and reached out to biodiesel manufacturers was dismal. FBO owners themselves, and restaurant and hotel associations admitted that barely 1 to 2 per cent of FBOs were aware of the fact that they could give or sell their UCO to biodiesel manufacturers (or UCO aggregators). This points to a serious lack of awareness and communication between the government, and the varied stakeholders in the UCO supply and value chain.

Whether collecting UCO directly, or through aggregators, manufacturers clarified that there was little to no loss in volume or wastage of UCO as a feedstock in the entire procurement process. Sludgy, turbid, or UCO deemed unfit as feedstock after testing, is returned on the spot at the FBO transaction level. This prevents the manufacturers and UCO aggregators from taking on unviable feedstock right at the outset. The burden of testing the raw material/feedstock (in this case, UCO) lies largely with biodiesel manufacturers and UCO aggregators. While testing could be an avenue in which FSSAI could well lend a hand, the understanding is that this may detract from their food safety functions and responsibilities. However, as a coordinating and regulatory agency, the least that FSSAI could do is put out testing standards and guidelines. Given that the FSSAI's regional offices are not fully aware of UCO disposal related guidelines and procedures, whether they would be able to suitably promote testing guidelines remains uncertain.

Manufacturers emphasised their preference for UCO as a feedstock, in comparison with palm stearin and tallow owing to the latter two being expensive to procure. The price difference is largely on account of both these feedstocks originating from imports, with the cost of customs duties and other charges passing on to the biodiesel manufacturers. More importantly, the conversion rate for feedstock to biodiesel is highest for UCO. Lower free fatty acids (FFAs), optimal pH, and moisture levels make UCO an almost ideal feedstock for most biodiesel manufacturers.

2.3 Pricing and Logistics of UCO

The price of biodiesel is determined by the input costs borne by biodiesel manufacturers. These input costs include the price of raw materials such as palm stearin, tallow, and UCO, infrastructure and other capital asset costs, as well as plant maintenance, running and labour costs. The cost of raw materials for biodiesel manufacture varies between INR 25-35 per kilogram or litre on the lower end, and INR 44 – 50 per kilogram or litre on the higher end. The higher end cost of raw materials is on account of palm stearin and tallow being imported, and therefore coming with attendant customs duties and other costs that make them more expensive. The price at which biodiesel manufacturers sell their product, especially when the feedstock is UCO, also depends on the cost of testing the raw material.

However, biodiesel manufacturers admitted that testing costs are quite affordable as they barely cross INR 0.50 per litre, especially for UCO.

The issue with UCO price is that it varies based on the quality of the UCO itself. The quality of the UCO is determined by the number of uses it has had. For example, if it has only been used once then it is still golden, slightly clouded, and without smell – which indicative of its quality could be priced much higher (up to INR 50-60 per litre) than UCO which has been used more than three times, which would have a characteristic deep brown colours, high viscosity and higher TPC content – and would therefore sell for much lower prices (as low as INR 20-25 per litre). The additional issue in this regard is that there is no set price scale for the varied quality types of UCO. This creates a variability in input costs for biodiesel manufacturers.

One of the major costs for biodiesel manufacturers are costs for equipment such as centrifuges, required for finishing the final product. While most of these are fixed costs, they become affordable only at larger scales of processing volumes, such as if a centrifuge that handles a 50 tons/hour is installed as opposed to one that processes only 10 tons/hour. Whether the manufacturer will have enough raw material, or specifically enough UCO to match such processing volumes is not certain. This becomes a concern in terms of maintenance, processing, and finishing costs for the final product.

Transport costs for UCO are not as high as for other feedstocks, except in the case that the UCO itself is imported (as reported by one biodiesel manufacturer). As some biodiesel manufacturers put it, as long as the UCO source is in the same state in which their plant is located, transport costs rarely go beyond INR 1 per kilogram or litre. Transport costs become unaffordable only when inter-state movement of UCO has to be resorted to. Inter-state movement of UCO usually costs the manufacturer INR 5-7/litre. This is one of the reasons that the setting up of biodiesel manufacture plants in various locations, within various states is a welcome move. UCO is also imported into India for biodiesel production, for which pricing and logistics rates depend on where it is sourced from. However, given that the price is equalised globally, the current price of UCO is USD 710/MT.

Therefore, the price build up for production of UCO based biodiesel is as follows;

Total Cost to Producer = Cost of raw material + Cost of testing/processing/finishing + Cost of transport/logistics

While the costs of raw material depend on the type of feedstock used (and is variable based on quality), the costs of testing, processing and finishing are fixed costs (though with some maintenance costs involved), and the approximate cost of transport is known only for UCO.

Price Build-up of UCO based biodiesel (per litre) = INR 25 – 50 + INR 0.50 (testing) + INR 1 (transport, within state) = INR 26.50 – 51.50.

The above price build-up is only based on the lower end of the price range of raw material quoted by biodiesel manufacturers. The base cost of raw material and transport is much higher for palm stearin and tallow. Compared to this price build-up, the price of biodiesel produced from UCO has been fixed since August 2019, for the upcoming three years. That is, the price is fixed at INR 51/litre from August 2019 to September 2020, INR 52.7/litre from October 2020 to September 2021, and INR 54.5/litre for the subsequent year.[32] Given the input costs discussed above, these prices are meant to encourage the uptake of biodiesel, but do not necessarily incentivise the manufacture of biodiesel, using UCO as a feedstock.

2.4 The Competition for UCO

Apart from biodiesel manufacture, UCO is largely used in the soap and oleo-chemical industries. In overall terms, of the annual edible oil consumption (which is a major factor influencing volumes of UCO available) in India two-thirds is consumed by households and FBOs, whereas one-third is consumed by the soap and oleo-chemical industries. Soap manufacturers are the biggest competition to biodiesel manufacturers in terms of UCO collection and procurement. However, the price differential offered by biodiesel manufacturers in order to procure UCO puts them at an advantage. Maintaining this advantage, and keeping the cost of UCO affordable for biodiesel manufacturers will be key to ensuring the requisite supply of UCO for biodiesel production is stable.

The UCO market in India remains unorganised however, and identification of viable sources of UCO (both in terms of collection and aggregation) remains a challenge. The reason UCO is identified as a public health hazard is because there is formation of Total Polar Compounds (TPCs) through repeated frying or heating of cooking oil. These TPCs are toxic and associated with several diseases such as hypertension,

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[32] T. V. Jayan, 'Portal to trace source of used cooking oil diverted for conversion to biodiesel', *The Hindu Businessline*, 27th December 2019. https://www.thehindubusinessline.com/economy/govt-unveils-portal-for-monitoring-used-cooking-oil-diverted-for-conversion-to-biodiesel/article30413321.ece

atherosclerosis, and liver dysfunction. As a result, FSSAI notified that cooking oil with more than 25 per cent TPCs is unfit for consumption. Thus, FBOs are required to dispose of UCO in an environmentally safe, and collection-friendly manner. However, there is a need to map the UCO supply chain, in order to identify the nature of the UCO market in the country. The next chapter will explore the UCO market, map the supply chain of UCO, and contextualise edible oil consumption patterns by source (commercial or household) to determine whether UCO is a viable and growing feedstock for biodiesel manufacture.

2.5 Market for By-products

The main by-product of the transesterification process for biodiesel production is crude glycerol. The transesterification process for waste vegetable oil (WVO, or used cooking oil – UCO) produces the highest amount of crude glycerol (76.6 per cent by weight)[33], as compared to other feedstocks. The crude glycerol received as a by-product has several impurities and is of scarce economic value in its by-product form. However, after removal of impurities and refining, the glycerin obtained finds application in industries like pharmaceuticals, cosmetics, solvents, and food processing.[34]

Crude glycerol given purification and refining is an expensive process and economically unviable for anyone except large biodiesel manufacturers.[35] Stand-alone units or plants may not be able to take on the cost of purifying, and therefore capitalising on crude glycerol as a source of revenue. Given its varied applications in its purified form however, there could be some consideration to setting up glycerol refining facilities with or near biodiesel plants. This would solve two issues, the problem that manufacturers face in disposing of crude glycerol, and the opportunity to capitalise on purified glycerol as an additional stream of revenue.

While several physicochemical and microbial processes are being tested to convert crude glycerol into potential value-added products such as surfactants and animal feed[36], these processes are yet to be scaled up to commercial levels with requisite efficiency. Therefore, until alternate avenues for treating or converting crude glycerol

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[33] J. C. Thomson and B. B. He, 'Characterization of Crude Glycerol from Biodiesel Production from Multiple Feedstocks', *Applied Engineering in Agriculture*, Vol. 22 (2), March (2006): pg. 263.

[34] 'New Uses for Crude Glycerin from Biodiesel Production', Farm Energy, 3rd April 2019. https://farm-energy.extension.org/new-uses-for-crude-glycerin-from-biodiesel-production/

[35] Jersson Placido and Sergio Capareda, 'Conversion of residues and by-products from the biodiesel industry into value-added products', *Bioresources and Bioprocessing*, Article No. 23, 17th May 2016. https://bioresourcesbioprocessing.springeropen.com/articles/10.1186/s40643-016-0100-1

[36] *Ibid*.

become available, the reliable option would be to focus on purifying and refining the crude glycerol.

Other by-products such as methanol are easily recovered during the transesterification process itself. Bio-residues such as pressed seed cakes, spent earth and agricultural waste find use as animal feed, or as fuel for producing hydrogen (though these processes have not shown high recovery rates). The market for these by-products does not provide much by way of revenue.

3. The Indian Used Cooking Oil (UCO) Market and Demand Growth

3.1 UCO Supply Chain

The used cooking oil (UCO) supply chain has varied stakeholders, chief among which are cooking oil manufacturing companies (fast moving consumer goods or FMCG companies), food business operators (FBOs), households, UCO aggregators, and biodiesel manufacturers. Each of these stakeholders has direct or indirect interactions with others in the supply chain. The supply chain begins with cooking oil manufacturers or the FMCG companies. In the context of the RUCO initiative and that of UCO based biodiesel, this supply chain culminates at biodiesel manufacturers, who are the ultimate recipients of UCO (refer Figure 3.1).

The movement and use of cooking oil is more easily traceable in terms of its commercial use. That is, through the food business operator (FBOs) and food product manufacturing or food processing value chains.

3.2 Commercial Cooking Oil Consumption Patterns

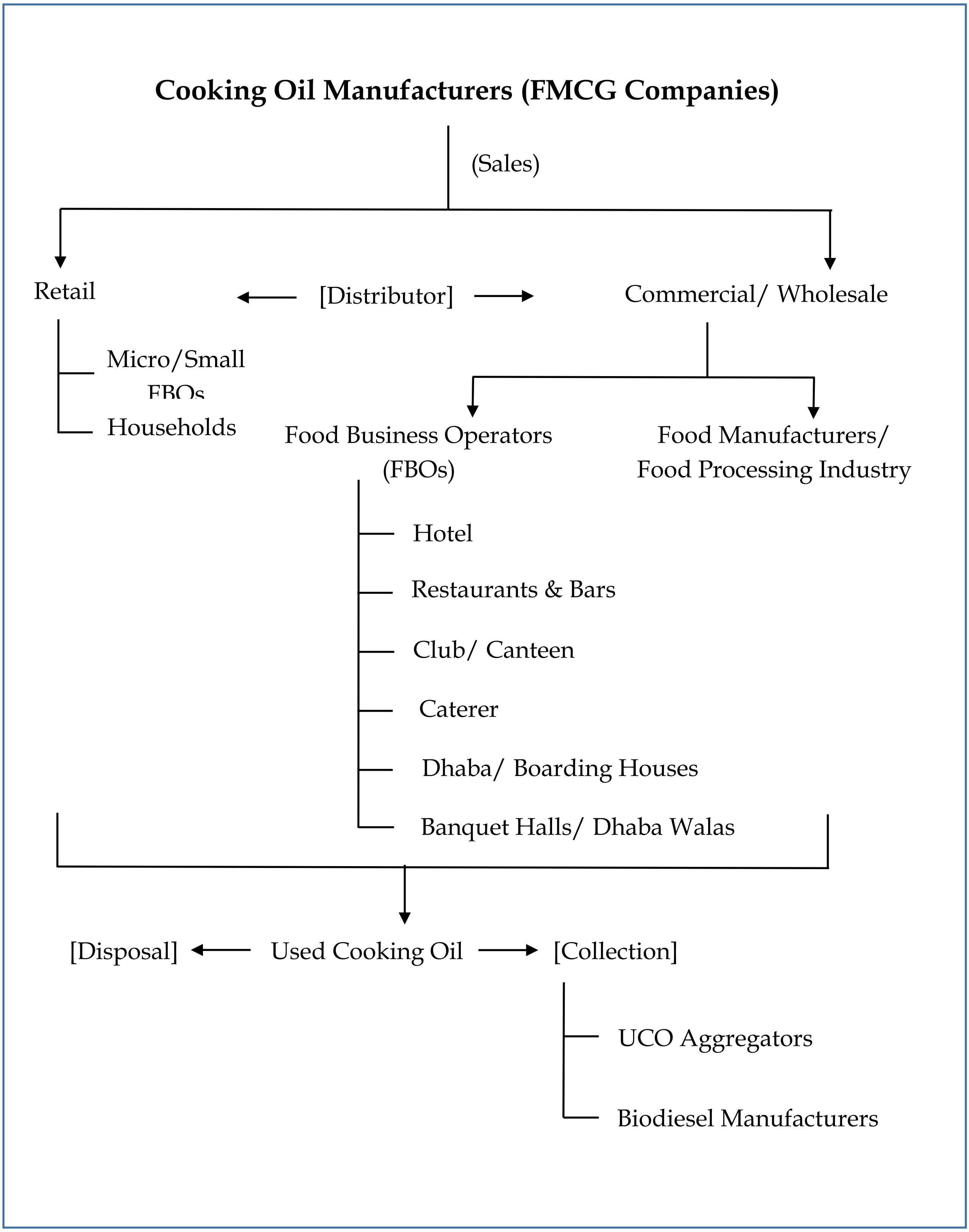
It is quite apparent that the volume and cost of cooking oil consumed will differ between households and FBOs. However, before getting into the details of the differences between consumption patterns, understanding the various categories of FBOs would be beneficial.

All FBOs and food-related production/processing companies are regulated by the Food Safety and Standards Authority of India (FSSAI). As per the Food Safety and Standards Regulations (2011), all food business operators in India must be registered with and licensed by the FSSAI.[37] This includes everyone from petty vendors (including hawkers and temporary stalls), to restaurant franchises and hotel chains. Among the various FBOs licensed or registered with the FSSAI, the following are some of the main categories;

- Hotels
- Restaurants and Bars
- Clubs/Canteens
- Caterers
- Dhabas/Boarding Houses
- Banquet Halls/Dabbawallas
- Stall Holders/Hawkers

[37] Chapter 2: 'Licensing and Registration of Food Business', Food Safety and Standards (Licensing and Registration of Food Businesses) Regulations, 2011.

Figure 3.1: Supply Chain of UCO[38]



[38] Compiled by authors based on information from stakeholders interviewed.

All the above categories have distinct definitions based on FSSAI regulations. Their licensing and registration requirements differ based on turnover, and in the case of hotels - the star rating assigned by the Ministry of Tourism (refer Table 3.1). The Indian food service industry, which includes almost all FBOs – has grown by leaps and bounds since the turn of the decade. In fact, between 2013 and 2017 the compound aggregate growth rate (CAGR) of the food service industry in India was approximately 5.3 per cent.[39]

Table 3.1: FBO Categories and License/Registration Criteria[40]

FBO Category	Criteria	License/Registration
HOTEL *A commercial establishment providing lodging, meals, and other guest services. (Establishment must have a minimum of six letting bedrooms, at least three of which must have ensuite private bathroom facilities.)*	Five Star and above	Central License
	Four Star and Three Star	State License
	Two Star, One Star, and Hotel without Star Rating from Ministry of Tourism (HRAAC)	State License
	Turnover upto INR 12 lacs per annum	Registration
RESTAURANTS & BARS *A type of food service operation which prepares and serves food and drinks to customers. Meals are generally served and eaten on premises, but many offer take-out and food delivery services, and some offer only take-out and delivery.*	Turnover more than INR 20 crores per annum	Central License
	Turnover upto INR 20 crores per annum	State License
	Turnover upto INR 12 lacs per annum	Registration

[39] 'Characteristics of India's Food Service Industry' – Chapter 1, *The Changing Landscape of the Retail Food Service Industry*, PwC and FICCI Report, December 2018: pg. 11.

[40] 'Business Categorisation and Eligibility for License or Registration', FSSAI.

FBO Category	Criteria	License/Registration
CLUBS & CANTEENS *A dining area in an institution or establishment serving food (prepared on premises or procured from other location or source) to individuals associated with or visiting the institution.*	Turnover more than INR 12 lacs per annum	State License
	Turnover upto INR 12 lacs per annum	Registration
CATERERS *Food service establishment involved in preparing, storage, serving and/or transport of food for consumption of a group at a venue of ceremony/celebration/ritual/institution.*	Turnover more than INR 20 crores per annum	Central License
	Turnover upto INR 20 crores per annum	State License
DHABAS *Food service establishment generally located near roadside/highway involved in processing, storing, packaging and selling food to customers for consumption.* **BOARDING HOUSES** *Building providing food and lodging for paying guest.*	Turnover more than INR 12 lacs per annum	State License
	Turnover upto INR 12 lacs per annum	Registration
BANQUET HALLS *Specified area, such as hall used for the purpose of hosting parties/ceremonies involved in preparation and serving of food to customers for consumption.*	Turnover more than INR 12 lacs per annum	State License
STALL HOLDERS & HAWKERS *A stand/booth/compartment/small covered area being used for preparation and/or sale of freshly prepared or packaged food for consumption. Structure may be temporary or permanent.*	Turnover more than INR 12 lacs per annum	State License
	Turnover upto INR 12 lacs per annum	Registration

**Only those FBOs that entail food preparation have been considered.*

The above FBO categories make up almost 96 per cent of the total market share of the food service industry in India, therefore constituting a major portion of the UCO supply. A 2017 report by PwC and FICCI provided a snapshot of the market share of major FBO categories (refer Table 3.2).

Table 3.2: Market Share by Food Service Category[41]

Category	Market Share (%)
Casual dining	55
Quick service restaurant and fast food	20
Pub, club, and bar	12
Café	7
Full service restaurant	2
Others	3

A report by Deloitte on food industry in India found that only 33 per cent of the Indian food service industry was organised.[42] The organised segment being made up of standalone restaurants, chains and restaurants in hotels. This meant that as of 2017, 67 per cent of the food service industry in India was unorganised, with the unorganised segment including dhabas, stalls, hawkers and the like. It is quite apparent that a significant part of India's food service industry, on account of being unorganised and perhaps hard to trace, does not figure in research, studies, or even industry and policy calculations. This becomes a limitation in terms of determining how much UCO the unorganised segment of the food service industry can provide.

Box 3.1: Factoring in the Food Manufacturing and Processing Industries

It is important to note here that we have only factored in FBOs as commercial sources so far. Food processing or food manufacturing industries, specifically those that produce fried or processed food items and tend to have high edible oil use, have not been factored into the above calculations. This is because there is scarce to no data available on this category of food business. As a result, it is almost impossible to estimate edible oil consumption and UCO potential of these industries. These industries are organised and easily traceable entities, who might prove to be important stakeholders in stepping up UCO collection. It will require the joint effort of FSSAI, MoP&NG, and industry associations, to get these industries on board as stakeholders within the RUCO initiative.

However, keeping in mind the FSSAI categorisation and licensing criteria, an estimation of the UCO potential of varied FBOs is possible. In order to ascertain the

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[41] 'Characteristics of India's Food Service Industry' – Chapter 1, *The Changing Landscape of the Retail Food Service Industry*, PwC and FICCI Report, December 2018: pg. 12.

[42] 'Food Ecosystem in India', *Industry 4.0 in Food Industry – India Food Report*, Deloitte, January 2018: pg. 8.

cooking/edible oil consumption of various big and small FBOs, PIF conducted a short survey of a limited number of FBOs across various cities. The survey data allowed us to create an estimate of the cooking/edible oil consumption of various eateries based on seating capacity. Given that seating capacity directly impacts income, and therefore turnover, this allowed a comparable parameter for determining the cooking/edible oil consumption, and consequently UCO potential of various FBOs. Data from the survey showed that the conversion factor of cooking/edible oil to used cooking oil was 15 per cent. This meant that on average, irrespective of the size of the eatery, 15 per cent of the total volume of oil consumed (in a month) was left over in the form of UCO.

Table 3.3: Monthly Oil Consumption based on Seating Capacity[43]

Seating	Monthly Oil Consumption (in litres)	UCO Left (in litres)
16-35	50-100	7.5-15
36-50	100-200	15-30
51-150	200-300	30-45
151-250	300-400	45-60
500+	300-500	45-75

The 'UCO Left' for each category of seating is calculated for the lower and upper consumption range figures, to take into account variability in monthly consumption, factor in differing cuisines which would impact volumes of oil consumption, and balance for variable number of outlets FBOs may have. The average cost of cooking oil per litre was found to be INR 100, based on the survey responses. This was corroborated through individual interviews with FBO owners/operators, and through a review of prevailing market prices.

The National Restaurants' Association of India's (NRAI) 'India Food Services Report 2019' stated that the food service industry in India grew at a CAGR of 11 per cent between 2015-16 and 2018-19. While the industry was projected to grow at 9 per cent CAGR by 2022-23, this projection will most certainly have contracted given the on-going pandemic and the economic crisis that has accompanied it. The unorganised segment's market share was estimated at INR 2,75,512 crores or 65 per cent of the overall food service market in 2018-19. However, this market share was already projected to contract to 57 per cent of the overall market by 2022-23. Whether this will hold true, or the unorganised segment's market share has taken a hit, both scenarios will be taken into account when UCO collection estimates are calculated. Before the

[43] Calculated based on data collected from survey conducted by authors.

UCO market and collection estimates are calculated, the next section will outline household cooking oil consumption patterns.

3.3 Household Cooking Oil Consumption Patterns

India's multitudinous cuisines, high population figure, and dynamic consumer preferences are all contributing factors to household cooking oil consumption patterns. From a national perspective, India's cooking oil consumption has shifted from a primarily mustard-rapeseed and groundnut oil, to palm, sunflower and soybean oils over the past decade or so. For the Indian population, the preference has largely always been for vegetable based cooking oils, rather than animal grease or fats. It is this preference for vegetable oils that also make households a stakeholder in the overall UCO supply chain and market. However, in order for households to become viable sources of UCO, there are a few obstacles to overcome. The least of which is awareness of UCO disposal and/or collection, and the greatest of which includes bringing about a change in cooking styles and habits – allowing for oil left over after cooking to be habitually separated and stored for later collection.

Table 3.4: Market Share of Edible Oils by Region (Household Consumption)[44]

Region	Market Share (in %)
North	25.20
South	19.65
East	25.51
West	29.64

Households in India have varying levels of oil consumption based on cuisine, region of residence, and other factors such as family size, expenditure preferences and more. In fact, the varied cuisines of the nation can explain the differences in cooking oil demand and consumption (refer Table 3.4). Apart from volume of cooking oil consumed, there are also differences in types of cooking oil used and preferred across the major regions. For instance, there is a preference for sesame and coconut cooking oils in the southern region, whereas the western region has a preference for sunflower and groundnut cooking oils. Given the higher share of cooking oil consumption in the eastern and western regions of India, these would be the regions to focus on for UCO collection, and specifically the implementation of the RUCO initiative.

[44] *India Edible Oil Market Report*, TechSci Research, March 2020. https://www.techsciresearch.com/report/india-edible-oil-market/4511.html

Per household cooking oil consumption is difficult to estimate, given the lack of reliable data or parameters. This is where per capita edible oil consumption is a reliable choice, as it provides a single parameter for consideration. This figure stood at 11.2 litres per person per year in 2008,[45] and rose to 17 litres per person per year by 2017.[46] While these per capita consumption figures are less than their corresponding world averages, they most certainly indicate growth in oil consumption at the individual level. This means that household edible oil consumption will have grown proportionately. The estimation of household level oil consumption is made possible by the availability of per capita edible oil consumption figures, and may allow us to estimate the probable volumes of UCO that could be collected from households across India, based on the country's total population.

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45 G. Govindaraj et al. 'Dynamics of Household Edible Oil Consumption in Rural and Urban Tamil Nadu', presented at International Association of Agricultural Economists Triennial Conference, August 2012: pg. 3.

46 'Indian Oil Scenario', Atul Chaturvedi, Adani Wilmar, 2018.

4. Estimation of UCO Collection from Commercial and Household Sources

4.1 On-Ground Availability and Collection Scenarios

The growing demand for edible oil in the nation at both the individual and consequently commercial levels, has been discussed in previous chapters. Limitations with the available data, specifically the lack of primary research in the form of surveys have also been emphasised. Additionally there is no proper split in terms of edible oil consumption by commercial and household categories. Therefore, scenario building is the most effective way to estimate different levels of availability and collection of UCO.

Overall demand, and per capita consumption of edible oil are projected to grow rapidly over the coming decade. This means that at varied levels of growth, the scenarios for UCO collection potential from household and commercial sources will differ. Given that overall per capita consumption figures equate to the total edible oil demand in India, factoring these figures into scenario calculations would not help arrive at a proper 'retail' and 'commercial' split in terms of edible oil consumption.

In order to overcome this particular setback, we use the projected figure for total edible oil demand in 2030 in combination with the edible oil to UCO conversion factor to calculate UCO collection potential for three scenarios of edible oil consumption. That is, we have taken into account a 25-75, 50-50, and 75-25 split for UCO collection from retail (household) and commercial (FBOs) sources. The volume of UCO that can be potentially collected from each source is calculated based on the scenario percentage split. This calculation will help us narrow down which of the two sources would be more feasible for boosting UCO collection over the coming decade.

Table 4.1: Scenarios for UCO Collection and Biodiesel Production in 2030 *(all figures in crore litres)*

Projected Edible Oil Demand for 2030: **3,695 crore litres**					
Biodiesel Target for 2030: **220 crore litres**					
Edible Oil to UCO Conversion Factor: **0.15 (15%)**					
UCO to Biodiesel Conversion Factor **0.9 (90%)**					
Scenario (R:C)	**Retail (R)**	**Commercial (C)**	**UCO Potential (from C)**	**Biodiesel Potential**	**Difference between Potential and Target**
25 – 75	923.75	2771.25	415.69	374.12	154.12
50 – 50	1847.50	1847.50	277.13	249.42	29.42
75 – 25	2771.25	923.75	138.56	124.70	- 95.30

Based on the calculations for household and FBOs' UCO potential in section 4.1, it is clear that calculating the edible oil consumption split between households and FBOs is difficult. The estimates of total number of FBOs, and total number of registered FBOs are available, and therefore useful in calculating UCO potential from FBOs (refer Table 4.). It has also been highlighted previously that without a primary survey of household level edible oil consumption, it is almost impossible to estimate whether households will prove to be a viable source for UCO collection. Therefore, in the above table, the UCO potential for only the commercial sources (FBOs) has been calculated. Given the above UCO potential in three different scenarios, the biodiesel potential for the same has also been calculated.

The above figures show UCO collection potential from commercial sources (FBOs), assuming that UCO is collected from all existing FBOs. However, barely 19 per cent of the estimated total number of FBOs in the country are registered with FSSAI. This makes it necessary to factor in scenarios where less than 100 per cent FBOs are covered in order to arrive at more realistic on-ground UCO collection potential. To calculate these scenarios, we have taken into account the percentage of current registered FBOs (19 per cent)[47], a potential increase in number of registered FBOs over the next couple of years (25 per cent), and a higher range of FBOs' coverage (60 per cent). (For calculating edible oil consumption at the retail (household level), the per capita edible oil consumption figure has been used which stands at 19 ltrs/person/year. This figure was used in combination with population figures to arrive at an annual household edible oil consumption figure, of which 75 per cent, 50 per cent, and 25 per cent consumption was calculated.)

Table 4.2: Scenarios of UCO Collection from FBOs based on registration coverage

Scenario (% of FBOs)	Scenario (R:C)	Edible Oil Consumed	UCO Potential	Biodiesel Potential	Difference (Potential – Target)
19	*75-25*	526.54	78.98	71.08	- 148.92
	50-50	351.03	52.65	47.39	- 172.61
	25-75	175.51	26.33	23.69	- 196.31
25	*75-25*	692.81	103.92	93.53	- 126.47
	50-50	461.88	69.28	62.35	- 157.65
	25-75	230.94	34.64	31.18	- 188.82
60	*75-25*	1662.75	249.41	224.47	4.47
	50-50	1108.50	166.28	149.65	- 70.35
	25-75	554.25	83.14	74.82	- 145.18

[47] Refer footnote 39.

The above scenarios make one thing amply clear, that commercial sources (specifically FBOs) alone will not be enough to meet the target volume of 244.5 crore litres of UCO and consequently the 220 crore litres of biodiesel to be produced from UCO. Whether feasible or not, the necessity for expanding to collection from retail sources seems inevitable. However, as highlighted in section 3.3 this may be a futile effort not only due to a lack of data, but also given that households may not have enough UCO left over to warrant collection. The first part of the following section will explore the limitations with household level collection

4.2 The Overall Estimates and Limitations

4.2.1 The Limitations of Household UCO Collection

It is quite apparent that an ideal scenario exists only on paper (refer sections 1.3 and 2.1) and not on the ground. Between the introduction of policy and its implementation are several hurdles that may adversely impact the total volume of UCO available, and collected. This is why the UCO available from household sources and commercial sources (largely FBOs) will be calculated, while factoring in variability in terms of consumption, use, and collection. This section will provide the overall estimates of UCO availability and collection from both household and commercial sources, based on a mix of secondary data (households) and primary survey data (FBOs).

In terms of commercial edible oil use, we have taken into account the FBOs and their UCO potential, based on the conversion factor calculated from the survey responses. For household use, we have taken into account India's per capita edible oil consumption and approximate total population figures. The figures chosen for the following calculations reflect an ideal scenario in terms of cooking oil consumption and left over oil collection. A zero-loss model, or a situation where the oil consumed, and the waste oil collected face no loss in volume during use, collection, and transport is presumed for the following calculations.

Table 4.3: UCO Available from Household Sources

Per capita edible oil consumption: **19 litres/person/year**[48]		
Population of India: **1.38 billion ~ 1.4 billion**[49]		
Annual Household Level Consumption	19 x 1,400,000,000	**2,660 crore litres**
Annual UCO from Households	0.15 x 2,660	**399 crore litres**

[48] Rajya Sabha Unstarred Question No. 708, 7th February 2020. https://commerce.gov.in/writereaddata/UploadedFile/MOC_637166782599628854_RS-07-02-2020.pdf

[49] India, Databank, World Bank, 2019. https://data.worldbank.org/indicator/SP.POP.TOTL?locations=IN

The total individual level edible oil consumption is roughly equal to the current total edible oil demand (2,660 crore litres ~ 2,750 crore litres, refer Table 1.7). This is largely due to how the demand itself is calculated, which is intrinsically easier to do using individual consumption or specifically, per capita consumption figures. It therefore follows, that the UCO left from individual/household consumption will approximately match the UCO volume calculated for total demand. This calculation has a significant limitation however, there is no clarity on whether the per capita consumption is based purely on household consumption, or whether this includes edible oil consumed through packaged food, processed food, or food prepared at FBOs.

There are other factors, such as cuisine, family size, personal preferences, as well as income levels and expenditure choices that impact any single household, or even individual's edible oil consumption. As a result, without a primary survey of a representative sample of varied households, determining the actual household consumption of edible oil, and consequently UCO potential of households will remain an uncertain exercise. One limitation that has not been addressed here, but that had come up in discussion with stakeholders is that the quantity of UCO to be collected from households might not be worth the effort of collection. The consensus being that households tend to almost entirely consume the edible oil they purchase.

4.2.2 FBOs UCO Potential

Given the limitations of calculating on-ground household cooking oil consumption, the other major stakeholders in the UCO supply chain or FBOs, can be examined for their UCO potential. As per the NRAI's India Food Services Report of 2019, there are an estimated 2.49 million (24,90,000) eateries or FBOs in the country. Only 4,67,000 FBOs of the estimated total are registered with the FSSAI.[50] This means that only 19 per cent of the estimated total number of eateries in the country are registered. Whether the total estimate captures the entire extent of the unorganised segment of the food service industry is difficult to confirm. However, in the interest of calculating the UCO potential of FBOs, the above numbers will be taken into account.

The cooking oil consumed in FBOs based on their seating capacity, as well as the UCO left over based on the standard conversion factor has already been shown in Section

[50] Shambhavi Anand and Sagar Malviya, 'Only 1 in 5 eateries in the country has a food safety license', *Economic Times*, 29th May 2019. https://economictimes.indiatimes.com/industry/cons-products/food/only-1-in-5-eateries-in-the-country-has-a-food-safety-licence/articleshow/69551344.cms?from=mdr

3.2. Following on from the same (refer Table 3.3), the figures provide a lower and upper average of monthly UCO availability from a single FBO (standalone or single outlet).

Table 4.4: Monthly UCO Availability in FBOs based on Seating Capacity[51]

Seating Capacity	**Monthly UCO Available** *(in ltrs)*	
	Lower Range	*Upper Range*
16 – 35	7.5	15
36 – 50	15	30
51 – 150	30	45
151 – 250	45	60
500+	45	75
Average	**28.5**	**45**

The average lower range and upper range of monthly UCO available from an FBO is 28.5 litres and 45 litres, respectively. In an ideal scenario, we can presume that UCO gets collected from all 2.49 million FBOs. In a more realistic appraisal, we presume that UCO gets collected at least from all FBOs registered with FSSAI. Though the actual situation on UCO collection from FBOs is far more dismal, as was found during discussions with stakeholders – including the FBOs themselves.

Table 4.5: UCO Available from all FBOs[52] **and all FBOs registered with FSSAI**[53]

Monthly UCO from single FBO: **28.5 litres – 45 litres**			
Annual UCO from all FBOs	*Lower Range*	28.5 x 12 x 24,90,000	**85.15 crore litres**
	Upper Range	45 x 12 x 24,90,000	**134.46 crore litres**
Annual UCO from all registered FBOs	*Lower Range*	28.5 x 12 x 4,67,000	**15.97 crore litres**
	Upper Range	45 x 12 x 4,67,000	**25.22 crore litres**

In an ideal scenario, FBOs would provide between 85.15 - 134.5 crore litres or between 20 to 33 per cent of the 412.5 crore litres of the current total UCO potential in India. In a more realistic, yet optimistic scenario all registered FBOs would provide anywhere between a meagre 4 to 6 per cent (15.97 – 25.22 crore litres) of the total UCO available in India. This indicates that UCO collection from FBOs needs to be stepped up by a significant factor. The first step to doing this however, is to increase registration of FBOs with FSSAI, thereby bringing as much of the unorganised segment into the

[51] Calculated by authors from compiled survey data.
[52] Figure for total FBOs in the country taken from NRAI's 'India Food Services Report 2019' estimate figure.
[53] Figure for total registered FBOs in the country taken from reported estimate FSSAI figure. Refer footnote 39.

organised fold of the food service industry. Part of the overall problem in leveraging the full potential of UCO availability from the food service industry is determining the extent of the unorganised segment and facilitating policy interventions that would incentivise their move into the organised sector.

It is important to highlight here that in the 25 per cent UCO collection from commercial sources scenario (refer Table 4.1), UCO potential stands at 138.56 crore litres, which is almost equivalent to the upper range UCO collection from all FBOs in India or 134.46 crore litres (refer Table 4.5). This indicates that if UCO collection from FBOs is stepped up, while simultaneously ensuring registration coverage of all possible FBOs in India, this collection potential can be attained in the medium term. This will also require that collection mechanisms be streamlined such that as many FBOs as possible are brought under the UCO collection umbrella. The streamlining and implementation of the registration and, collection and aggregation processes will need to be a joint effort of stakeholders at various levels, helmed by FSSAI and MoP&NG.

However, it is equally important to emphasise that this level of UCO collection will still only satisfy just over 50 per cent of the target volume of UCO required, which is 244.5 crore litres (in order to meet the biodiesel target volume of 220 crore litres). It is interesting to note however, that in the 50 per cent split scenario, the UCO potential and subsequently the biodiesel potential stand at 277.13 crore litres and 249.42 crore litres respectively. This UCO collection and biodiesel production potential cover the target volumes of 244.5 crore litres and 220 crore litres respectively. While this is a promising scenario, the feasibility of its attainment remains uncertain. An additional point of analysis here is that, given that only FBOs have been taken into account as commercial sources of UCO, half of this 50 per cent scenario may also entail tapping into the food manufacturing and processing industries (refer Box 3.1). Bringing these industries to the table as stakeholders might prove beneficial in boosting overall UCO collection from organised sources.

For a more realistic collection potential, if we take that UCO is collected only from the registered FBOs, then UCO potential stands at 15.97 crore litres on the lower end, to 25.22 crore litres on the higher end (refer Table 4.5). This accounts for barely 7 to 10 per cent of the target 244.5 crores litres of UCO required. These figures therefore emphasise that while commercial sources (FBOs) are indeed the ones that will help boost UCO collection in the medium and long term, in order to capitalise on their UCO potential the food service industry's unorganised sector must be brought into the organised fold. This must begin with FSSAI ensuring the mandatory registration of FBOs of all sizes, and this must be followed up by awareness drives and stakeholder interactions to highlight the benefits (economic, environmental, and social) of UCO collection, as opposed to UCO disposal.

The above scenarios and figures highlight that UCO collection from retail (household) sources is near impossible, or not worth the effort it may take. It does show that commercial sources are the way to go, as far as tapping into India's UCO potential is concerned. While current levels of UCO collection from FBOs may be far from ideal, they can certainly be improved. This will require policy and process interventions at two levels. First, bringing as many FBOs under the registration net of FSSAI as possible to improve UCO tracing and collection. Second, ensuring that all stakeholders involved in UCO collection and aggregation are aware of requisite guidelines, processes, and regulations related to the same. This will ensure that UCO collection levels are gradually increased over the coming years, to eventually meet 2030 target volumes for biodiesel production and blending.

4.3 Prospect in Achieving 5 per cent blending by 2030

The target of 5 per cent biodiesel blending by 2030 is achievable, especially given that other nations with smaller populations have been able to meet their blending mandates. However, the achievement of target blending within the anticipated timeline will be challenging, given the current circumstances and pace of policy implementation. There are major implementation hurdles that need to be overcome, the first of which begins at the level of boosting and improving UCO collection mechanisms. While overall edible oil consumption figures suggest that there is enough potential UCO volume in the nation, the collection and conversion of this UCO potential is where the crux of the problem lies. Even if, as discussed in previous chapters, the collection of UCO from FBOs and industries is stepped up – the total UCO potential of the nation cannot be fully exploited, as collection from households will remain a persistent obstacle.

However, this prognosis is meant to encourage, not dissuade the pursuit of production of biodiesel from UCO. UCO is a disposable material that gains economic value if converted to biofuel use, while also becoming a source of revenue for stakeholders in its supply chain and for biodiesel manufacturers as well. Current UCO collection volumes may not be adequate in boosting biodiesel production to meet the target blending percentage. Therefore, the focus of policy should be on boosting UCO collection mechanisms, and bringing all relevant stakeholders to the table to collaborate on tapping into India's UCO potential and improving production of UCO based biodiesel.

The concluding chapter provides a few pointed recommendations for tapping into India's UCO potential in order to boost UCO collection to progress towards meeting target volumes.

5. Recommendations for Tapping into the UCO Potential of India

Based on the findings of this study, there are a few policy and process recommendations we would suggest in order to help tap into India's UCO potential, boost collection, and therefore biodiesel production. This paper has established that the overall UCO potential for meeting biodiesel production from UCO already exists in the country, based on edible oil demand and consumption figures. Just a few improvements to policy and process will help tap into this potential, despite the limitations that have been highlighted.

- Conducting detailed or pilot studies for data collection from varied stakeholders in India's UCO market, is necessary in order to arrive at more accurate estimates than are currently available. This is applicable at all levels of stakeholders from FBOs (and their various categories), to households (for household-level consumption patterns), and for bringing relevant stakeholders like the food manufacturing and processing industries (determining their oil consumption and UCO potential) under the UCO collection umbrella. The granularity of data collected must also be improved, as mere overall consumption volumes will not provide accurate estimates of split across 'retail' and 'commercial' sources.

- A pilot survey of food manufacturing and processing industries in India should be commissioned. The survey should focus on determining average edible oil consumption by unit for these industries, from which UCO potential can be calculated. Additionally the survey should also focus on mapping oil consumption to food products, unit size, and turnover to arrive at standardised weighted averages. The sample size of such a survey can be arrived at by working backwards from deficit volumes of UCO to be made up to get the number of industry units that need to be targeted in the immediate and medium term.

- The focus for UCO collection in the first three years of this decade, that is from 2020 – 2023 should be on the Western and Northern regions of India, where oil consumption market shares are highest (refer Table 3.4). The states of Delhi, Haryana, Bihar, and Uttar Pradesh in the North, and Maharashtra, Rajasthan, and Gujarat in the West, should be specifically targeted, as they are also on the OMCs' list of locations for setting up biodiesel production plants.

- Streamlining collection mechanisms will require improvements in communication and stakeholder interactions. It will also require improving registration coverage of unorganised eateries (FBOs) by FSSAI. This needs to be accompanied by FSSAI interactions with stakeholders, largely those that are unorganised (that is, those FBOs which are not members of or part of any association or organisation of the food service industry). While this may be a time-intensive process, it may be worth the effort not only in terms of improving registration and helping establish a more efficient UCO tracing mechanism, but also in terms of boosting actual UCO collection.

- Testing is largely carried out by aggregators and biodiesel manufacturers, however, it was highlighted that FSSAI's support in this regard would be welcome. Biodiesel manufacturers have the resources to carry out the testing, however FSSAI could issue testing guidelines for UCO in order to create a standardised information sheet, which all stakeholders (including FBOs, and even households) could refer to in case of discrepancies or doubts. This could be the first step for FSSAI to be further integrated into the UCO ecosystem, especially in its capacity as a regulator and government agency.

- MoP&NG and FSSAI, in collaboration with food service industry associations can help run awareness programs or workshops regarding UCO collection by UCO aggregators and biodiesel manufacturers, and the social costs and environmental hazards of disposing UCO. While this has been attempted by FSSAI and a few hotel and restaurant associations, the scale of such events must be increased. In fact, such programs and workshops should become an intrinsic part of the RUCO initiative.

- FSSAI's regional offices need to be trained and updated on the objectives of the RUCO initiative, and the tools for implementation of the same. It has been noted through interactions with FBOs, associations, and biodiesel manufacturers that often regional-level officers of FSSAI know little about the RUCO initiative overall, and are therefore unable to provide requisite information or assistance to any stakeholders that may approach them. For effective implementation of this initiative, and for it to eventually help boost UCO collection, communication and coordination between the regional and central offices of FSSAI needs to be improved.

The above recommendations are relatively simple and are zero-cost. The latter is owing to the fact that UCO – an otherwise disposable material takes on economic value for the suppliers (FBOs and others), as UCO aggregators and biodiesel manufacturers are more than willing to pay for the UCO and even collect it. This serves as an intrinsically incentivised model, as long as government agencies and regulators are willing to take on the effort of communication and interaction with stakeholders for improved awareness and collaborative effort.

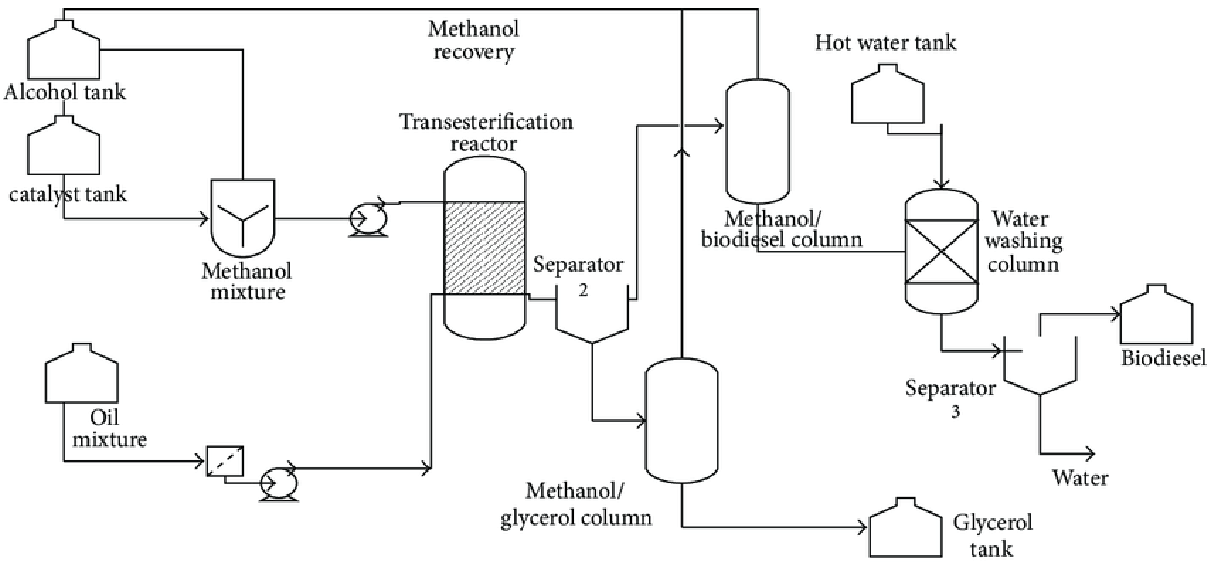
APPENDICES

APPENDIX A

1. The Process of Manufacturing Biodiesel from UCO

Used cooking oil (or waste cooking oil) is one of three main feedstocks for biodiesel manufacture. The other two are palm stearin and tallow. The production of biodiesel from any of these three feedstocks is largely through transesterification, or esterification, though the former is preferred owing to a higher conversion rate. In the case of transesterification, the conversion rate for feedstock to biodiesel is over 90 per cent. The exact conversion rates differ based on the specific transesterification methods used by the biodiesel manufacturer, including differences in alcohol and type of catalyst used.

Figure 2.1: Biodiesel Manufacture from UCO[54]



[54] Arul Jesu Gnanaprakasam et al. "Recent Strategy of Biodiesel Production from Waste Cooking Oil and Process Influencing Parameters: A Review", *Journal of Energy*, May 2013: pg. 7.

APPENDIX B

List of Cities Identified in EOI for Upcoming and Planned Biodiesel Production Plants

S. No.	Name of the City/District/Geographical Area	State
1	Vizianagaram	Andhra Pradesh
2	YSR	Andhra Pradesh
3	East Godavari	Andhra Pradesh
4	Visakhapatnam	Andhra Pradesh
5	Guntur	Andhra Pradesh
6	West Godavari	Andhra Pradesh
7	Anantapur	Andhra Pradesh
8	Chittoor	Andhra Pradesh
9	Krishna	Andhra Pradesh
10	Kurnool	Andhra Pradesh
11	Prakasam	Andhra Pradesh
12	Sri Potti Sriramulu (Nellore)	Andhra Pradesh
13	Papum Pare(Itanagar)	Arunachal Pradesh
14	Nagaon	Assam
15	Kamrup Metropolitan	Assam
16	Nalanda	Bihar
17	Muzaffarpur	Bihar
18	Patna	Bihar
19	Gaya	Bihar
20	Begusarai	Bihar
21	Bhagalpur	Bihar
22	Darbhanga	Bihar
23	Katihar	Bihar
24	Madhubani	Bihar
25	Pashchim Champaran	Bihar
26	Purbi Champaran	Bihar
27	Pumia	Bihar
28	Rohtas	Bihar
29	Samastipur	Bihar
30	Saran	Bihar
31	Sitamarhi	Bihar
32	Si wan	Bihar
33	Vaishali	Bihar
34	Chandigarh	Chandigarh
35	Raigarh	Chhattisgarh
36	Raipur	Chhattisgarh
37	Durg	Chhattisgarh
38	East Delhi	Delhi

S. No.	Name of the City/District/Geographical Area	State
39	North West Delhi	Delhi
40	South Delhi	Delhi
41	South West Delhi	Delhi
42	North East Delhi	Delhi
43	West Delhi	Delhi
44	North Delhi	Delhi
45	Central Delhi	Delhi
46	North Goa	Goa
47	South Goa	Goa
48	Kachchh	Gujarat
49	Jamnagar	Gujarat
50	Bhavnagar	Gujarat
51	Ahmedabad	Gujarat
52	Patan	Gujarat
53	Surat	Gujarat
54	Junagadh	Gujarat
55	Gandhinagar	Gujarat
56	Anand	Gujarat
57	Rajkot	Gujarat
58	Vadodara	Gujarat
59	Bharuch	Gujarat
60	Banaskantha	Gujarat
61	Valsad	Gujarat
62	Gurgaon	Haryana
63	Faridabad	Haryana
64	Ambala	Haryana
65	Sonipat	Haryana
66	Shimla	Himachal Pradesh
67	Srinagar	Jammu & Kashmir
68	Jammu	Jammu & Kashmir
69	East Singhbhum	Jharkhand
70	Bokaro	Jharkhand
71	Ranchi	Jharkhand
72	Dakshina Kannada	Karnataka
73	Bellary	Karnataka
74	Mysore	Karnataka
75	Bangalore	Karnataka
76	Tumkur	Karnataka
77	Belgaum	Karnataka
78	Bangalore Rural	Karnataka
79	Chikmagalur	Karnataka
80	Raichur	Karnataka

S. No.	Name of the City/District/Geographical Area	State
81	Kollam	Kerala
82	Thiruvananthapuram	Kerala
83	Kozhikode	Kerala
84	Ernakulam	Kerala
85	Malappuram	Kerala
86	Thrissur	Kerala
87	Bhopal	Madhya Pradesh
88	Gwalior	Madhya Pradesh
89	Indore	Madhya Pradesh
90	Jabalpur	Madhya Pradesh
91	Tikamgarh	Madhya Pradesh
92	Mumbai City	Maharashtra
93	Pune	Maharashtra
94	Jalgaon	Maharashtra
95	Thane	Maharashtra
96	Ahmadnagar	Maharashtra
97	Nashik	Maharashtra
98	Aurangabad	Maharashtra
99	Solapur	Maharashtra
100	Nagpur	Maharashtra
101	Raigad	Maharashtra
102	Kolhapur	Maharashtra
103	Nandurbar	Maharashtra
104	Mumbai Suburban	Maharashtra
105	Amravati	Maharashtra
106	Jalna	Maharashtra
107	Nanded	Maharashtra
108	Satara	Maharashtra
109	Imphal West	Manipur
110	East Khasi Hills	Meghalaya
111	Aizawl	Mizoram
112	Kohima	Nagaland
113	Cuttack	Odisha
114	Bhubaneswar	Odisha
115	Berhampur (District Ganjam)	Odisha
116	Puri	Odisha
117	Rourkela	Odisha
118	Amritsar	Punjab
119	Jalandhar	Punjab
120	Ludhiana	Punjab
121	Bathinda	Punjab
122	Patiala	Punjab

S. No.	Name of the City/District/Geographical Area	State
123	Alwar	Rajasthan
124	Chittaurgarh	Rajasthan
125	Jaisalmer	Rajasthan
126	Kota	Rajasthan
127	Nagaur	Rajasthan
128	Pali	Rajasthan
129	Sawai Madhopur	Rajasthan
130	Bikaner	Rajasthan
131	Ajmer	Rajasthan
132	Udaipur	Rajasthan
133	Jodhpur	Rajasthan
134	Jaipur	Rajasthan
135	Vellore	Tamil Nadu
136	Tiruppur	Tamil Nadu
137	Chennai	Tamil Nadu
138	Coimbatore	Tamil Nadu
139	Madurai	Tamil Nadu
140	Salem	Tamil Nadu
141	Kancheepuram	Tamil Nadu
142	Thiruvallur	Tamil Nadu
143	Thoothukkudi	Tamil Nadu
144	Tirunelveli	Tamil Nadu
145	Viluppuram	Tamil Nadu
146	Hyderabad	Telangana
147	West Tripura	Tripura
148	Gautam Buddha Nagar	Uttar Pradesh
149	Mathura	Uttar Pradesh
150	Varanasi	Uttar Pradesh
151	Kanpur Nagar	Uttar Pradesh
152	Bareilly	Uttar Pradesh
153	Lucknow	Uttar Pradesh
154	Meerut	Uttar Pradesh
155	Allahabad	Uttar Pradesh
156	Agra	Uttar Pradesh
157	Aligarh	Uttar Pradesh
158	Firozabad	Uttar Pradesh
159	Ghaziabad	Uttar Pradesh
160	Azamgarh	Uttar Pradesh
161	Bahraich	Uttar Pradesh
162	Ballia	Uttar Pradesh
163	Barabanki	Uttar Pradesh
164	Bijnor	Uttar Pradesh

S. No.	Name of the City/District/Geographical Area	State
165	Budaun	Uttar Pradesh
166	Bulandshahar	Uttar Pradesh
167	Ghazipur	Uttar Pradesh
168	Gonda	Uttar Pradesh
169	Gorakhpur	Uttar Pradesh
170	Hardoi	Uttar Pradesh
171	Jaunpur	Uttar Pradesh
172	Jhansi	Uttar Pradesh
173	Kheri	Uttar Pradesh
174	Kushinagar	Uttar Pradesh
175	Moradabad	Uttar Pradesh
176	Muzaffamagar	Uttar Pradesh
177	Pratapgarh	Uttar Pradesh
178	Rae Bareli	Uttar Pradesh
179	Saharanpur	Uttar Pradesh
180	Sitapur	Uttar Pradesh
181	Sultanpur	Uttar Pradesh
182	Unnao	Uttar Pradesh
183	Dehradun	Uttarakhand
184	Udham Singh Nagar	Uttarakhand
185	Murshidabad	West Bengal
186	South Twenty Four Parganas	West Bengal
187	Nadia	West Bengal
188	Paschim Medinipur	West Bengal
189	North Twenty Four Parganas	West Bengal
190	Barddhaman	West Bengal
191	Haora	West Bengal
192	Hugh	West Bengal
193	Kolkata	West Bengal
194	Bankura	West Bengal
195	Birbhum	West Bengal
196	Darjiling	West Bengal
197	Jalpaiguri	West Bengal
198	Maldah	West Bengal
199	Purba Medinipur	West Bengal
200	Uttar Dinajpur	West Bengal

List of Additional 100 Cities

S. No.	Name of the City/District/Geographical Area	State
1	Eluru	Andhra Pradesh
2	Kadapa	Andhra Pradesh
3	Kakinada	Andhra Pradesh
4	Machilipatnam	Andhra Pradesh
5	Yupia	Arunachal Pradesh
6	Changlang	Arunachal Pradesh
7	Tezu	Arunachal Pradesh
8	Along	Arunachal Pradesh
9	Dhubri	Assam
10	Tezpur	Assam
11	Silchar	Assam
12	Barpeta	Assam
13	Goroimari	Assam
14	Bihar Sharif	Bihar
15	Motihari	Bihar
16	Chhapra	Bihar
17	Bettiah	Bihar
18	Hajipur	Bihar
19	katihar	Bihar
20	Ambikapur	Chhattisgarh
21	Naila Janjgir	Chhattisgarh
22	Rajnandgaon	Chhattisgarh
23	Jagdalpur	Chhattisgarh
24	Silvassa	Dadra Nahar Haveli
25	Daman	Daman Din
26	Din	Daman Din
27	Bhuj	Gujarat
28	Palanpur	Gujarat
29	Godhra	Gujarat
30	Mehsana	Gujarat
31	Surendranagar	Gujarat
32	Morbi	Gujarat
33	Hissar	Haryana
34	Bhiwani	Haryana
35	Jind	Haryana
36	Sirsa	Haryana
37	Yamuna Nagar	Haryana
38	Panipat	Haryana
39	Dharamshala	Himachal Pradesh
40	Mandi	Himachal Pradesh

S. No.	Name of the City/District/Geographical Area	State
41	Solan	Himachal Pradesh
42	Anantnag	Jammu & Kashmir
43	Baramulla	Jammu & Kashmir
44	Kupwara	Jammu & Kashmir
45	Udhampur	Jammu & Kashmir
46	Leh	Jammu & Kashmir
47	Jamshedpur	Jharkhand
48	Dhanbad	Jharkhand
49	Giridih	Jharkhand
50	Daltonganj	Jharkhand
51	Hazaribag	Jharkhand
52	Mangalore	Karnataka
53	Bellary	Karnataka
54	Gulbarga	Karnataka
55	Bijapur	Karnataka
56	Kakkanad	Kerala
57	Palakkad	Kerala
58	Karmur	Kerala
59	Morena	Madhya Pradesh
60	Jhabua	Madhya Pradesh
61	Rewa	Madhya Pradesh
62	Ratlam	Madhya Pradesh
63	Sagar	Madhya Pradesh
64	Alibag	Maharashtra
65	Sangli	Maharashtra
66	Buldhana	Maharashtra
67	Bhandara	Maharashtra
68	Lamphelpat	Manipur
69	Porompat	Manipur
70	Thoubal	Manipur
71	Shillong	Meghalaya
72	Tura	Meghalaya
73	Lunglei	Mizoram
74	Champhai	Mizoram
75	Dimapur	Nagaland
76	Mon	Nagaland
77	Chhatrapur	Odisha
78	Baripada	Odisha
79	Balasore	Odisha
80	Khordha	Odisha
81	Puducherry	Puducherry
82	Gurdaspur	Punjab

S. No.	Name of the City/District/Geographical Area	State
83	Firozpur	Punjab
84	Sangrur	Punjab
85	Tarn Taran Sahib	Punjab
86	Moga	Punjab
87	Malkajgiri	Telangana
88	Nalgonda	Telangana
89	Nizamabad	Telangana
90	K ham mam	Telangana
91	Mahbubnagar	Telangana
92	Warangal	Telangana
93	Suryapet	Telangana
94	Rampur	Uttar Pradesh
95	Mau	Uttar Pradesh
96	Balrampur	Uttar Pradesh
97	Purulia	West Bengal
98	Cooch Behar	West Bengal
99	Balurghat	West Bengal
100	Alipurduar	West Bengal

APPENDIX C

UCO Potential of Listed 300 Cities/Geographical Areas

Sr. No.	City	State	Population (2011)	Population (2020 est.)	UCO Potential (in litres)
1	Vizianagaram	Andhra Pradesh	2,28,025	2,51,619	717113.21
2	YSR	Andhra Pradesh	28,82,469	31,80,717	9065043.77
3	East Godavari	Andhra Pradesh	51,54,296	56,87,609	16209686.51
4	Visakhapatnam	Andhra Pradesh	17,28,128	19,06,937	5434769.97
5	Guntur	Andhra Pradesh	7,43,354	8,20,269	2337765.49
6	West Godavari	Andhra Pradesh	39,36,966	43,44,323	12381319.32
7	Anantapur	Andhra Pradesh	3,40,613	3,75,856	1071189.93
8	Chittoor	Andhra Pradesh	1,52,654	1,68,449	480079.82
9	Krishna	Andhra Pradesh	45,17,398	49,84,812	14206713.28
10	Kurnool	Andhra Pradesh	4,84,372	5,34,490	1523295.96
11	Prakasam	Andhra Pradesh	33,97,448	37,48,981	10684595.34
12	Sri Potti Sriramulu (Nellore)	Andhra Pradesh	4,04,775	4,46,657	1272972.27
13	Papum Pare(Itanagar)	Arunachal Pradesh	1,76,573	1,94,843	555302.41
14	Nagaon	Assam	1,47,231	1,62,465	463025.09
15	Kamrup Metropolitan	Assam	12,53,938	13,83,683	3943495.27
16	Nalanda	Bihar	28,77,653	31,75,403	9049897.99
17	Muzaffarpur	Bihar	3,93,724	4,34,462	1238218.10
18	Patna	Bihar	16,95,000	18,70,381	5330586.10
19	Gaya	Bihar	4,70,839	5,19,557	1480736.18
20	Begusarai	Bihar	2,51,136	2,77,121	789794.73
21	Bhagalpur	Bihar	4,10,210	4,52,654	1290064.74
22	Darbhanga	Bihar	2,94,116	3,24,548	924962.04
23	Katihar	Bihar	2,40,565	2,65,456	756550.12
24	Madhubani	Bihar	75,736	83,572	238181.28
25	Pashchim Champaran	Bihar	39,35,042	43,42,199	12375268.56
26	Purbi Champaran	Bihar	50,99,371	56,27,001	16036953.51
27	Pumia	Bihar	3,10,817	3,42,977	977484.83
28	Rohtas	Bihar	29,59,918	32,66,180	9308612.25
29	Samastipur	Bihar	62,935	69,447	197923.56
30	Saran	Bihar	39,51,862	43,60,760	12428165.58
31	Sitamarhi	Bihar	1,06,093	1,17,070	333650.66
32	Siwan	Bihar	1,35,066	1,49,041	424767.52
33	Vaishali	Bihar	34,95,021	38,56,650	10991451.55
34	Chandigarh	Chandigarh	10,55,450	11,64,657	3319272.63
35	Raigarh	Chhattisgarh	3,85,000	4,24,836	1210782.09

Sr. No.	City	State	Population (2011)	Population (2020 est.)	UCO Potential (in litres)
36	Raipur	Chhattisgarh	10,10,087	11,14,600	3176611.05
37	Durg	Chhattisgarh	2,68,679	2,96,479	844965.51
38	East Delhi	Delhi	17,09,346	18,86,211	5375702.68
39	North West Delhi	Delhi	36,56,539	40,34,880	11499407.66
40	South Delhi	Delhi	27,31,929	30,14,601	8591612.25
41	South West Delhi	Delhi	22,92,958	25,30,210	7211097.38
42	North East Delhi	Delhi	22,41,624	24,73,564	7049657.67
43	West Delhi	Delhi	25,43,243	28,06,392	7998215.81
44	North Delhi	Delhi	8,87,978	9,79,857	2792591.85
45	Central Delhi	Delhi	5,82,320	6,42,572	1831331.50
46	North Goa	Goa	8,18,008	9,02,647	2572544.00
47	South Goa	Goa	6,40,537	7,06,813	2014417.48
48	Kachchh	Gujarat	20,92,371	23,08,868	6580273.62
49	Jamnagar	Gujarat	4,79,920	5,29,577	1509294.92
50	Bhavnagar	Gujarat	6,43,365	7,09,934	2023311.23
51	Ahmedabad	Gujarat	56,33,927	62,16,868	17718072.55
52	Patan	Gujarat	1,33,744	1,47,582	420609.98
53	Surat	Gujarat	44,67,797	49,30,078	14050723.66
54	Junagadh	Gujarat	3,19,462	3,52,517	1004672.39
55	Gandhinagar	Gujarat	2,92,167	3,22,397	918832.66
56	Anand	Gujarat	2,18,486	2,41,093	687114.12
57	Rajkot	Gujarat	14,42,975	15,92,279	4537995.57
58	Vadodara	Gujarat	18,22,221	20,10,766	5730681.97
59	Bharuch	Gujarat	1,48,391	1,63,745	466673.16
60	Banaskantha	Gujarat	31,20,506	34,43,384	9813643.61
61	Valsad	Gujarat	1,70,060	1,87,656	534819.75
62	Gurgaon	Haryana	8,76,900	9,67,633	2757752.78
63	Faridabad	Haryana	14,04,653	15,49,992	4417477.15
64	Ambala	Haryana	2,07,934	2,29,449	653929.26
65	Sonipat	Haryana	2,78,149	3,06,929	874747.61
66	Shimla	Himachal Pradesh	1,69,578	1,87,124	533303.91
67	Srinagar	Jammu & Kashmir	11,80,570	13,02,723	3712761.08
68	Jammu	Jammu & Kashmir	5,02,197	5,54,159	1579353.60
69	East Singhbhum	Jharkhand	22,93,919	25,31,270	7214119.61
70	Bokaro	Jharkhand	5,63,417	6,21,714	1771883.68
71	Ranchi	Jharkhand	14,56,528	16,07,234	4580618.24
72	Dakshina Kannada	Karnataka	20,89,649	23,05,864	6571713.23
73	Bellary	Karnataka	4,10,445	4,52,914	1290803.78
74	Mysore	Karnataka	9,20,550	10,15,799	2895027.16

Sr. No.	City	State	Population (2011)	Population (2020 est.)	UCO Potential (in litres)
75	Bangalore	Karnataka	84,43,675	93,17,339	26554416.89
76	Tumkur	Karnataka	3,05,821	3,37,464	961772.96
77	Belgaum	Karnataka	4,88,292	5,38,815	1535623.92
78	Bangalore Rural	Karnataka	9,90,923	10,93,453	3116342.40
79	Chikmagalur	Karnataka	1,18,401	1,30,652	372357.95
80	Raichur	Karnataka	2,32,456	2,56,508	731048.21
81	Kollam	Kerala	3,97,419	4,38,540	1249838.47
82	Thiruvananthapuram	Kerala	9,57,730	10,56,826	3011954.12
83	Kozhikode	Kerala	6,09,224	6,72,260	1915941.59
84	Ernakulam	Kerala	32,82,388	36,22,016	10322744.46
85	Malappuram	Kerala	1,01,386	1,11,876	318847.67
86	Thrissur	Kerala	3,15,596	3,48,251	992514.25
87	Bhopal	Madhya Pradesh	17,98,218	19,84,279	5655195.21
88	Gwalior	Madhya Pradesh	10,69,276	11,79,914	3362753.86
89	Indore	Madhya Pradesh	19,94,397	22,00,757	6272156.30
90	Jabalpur	Madhya Pradesh	12,67,564	13,98,718	3986347.52
91	Tikamgarh	Madhya Pradesh	79,106	87,291	248779.55
92	Mumbai City	Maharashtra	1,24,78,447	1,37,69,588	39243325.18
93	Pune	Maharashtra	31,24,458	34,47,745	9826072.21
94	Jalgaon	Maharashtra	4,60,668	5,08,333	1448749.52
95	Thane	Maharashtra	18,86,941	20,82,182	5934219.16
96	Ahmadnagar	Maharashtra	3,50,905	3,87,213	1103557.12
97	Nashik	Maharashtra	14,86,973	16,40,830	4676364.37
98	Aurangabad	Maharashtra	11,75,116	12,96,705	3695608.86
99	Solapur	Maharashtra	9,51,118	10,49,530	2991160.11
100	Nagpur	Maharashtra	24,05,665	26,54,578	7565548.33
101	Raigad	Maharashtra	26,34,200	29,06,760	8284265.44
102	Kolhapur	Maharashtra	5,49,236	6,06,065	1727286.01
103	Nandurbar	Maharashtra	1,11,000	1,22,485	349082.63
104	Mumbai Suburban	Maharashtra	93,56,962	1,03,25,124	29426602.72
105	Amravati	Maharashtra	6,47,057	7,14,008	2034922.16
106	Jalna	Maharashtra	2,85,577	3,15,126	898107.84
107	Nanded	Maharashtra	5,50,439	6,07,393	1731069.31
108	Satara	Maharashtra	3,26,079	3,59,818	1025482.12
109	Imphal West	Manipur	2,68,243	2,95,998	843594.34
110	East Khasi Hills	Meghalaya	8,25,922	9,11,380	2597432.65
111	Aizawl	Mizoram	2,93,416	3,23,776	922760.62
112	Kohima	Nagaland	1,15,283	1,27,211	362552.19
113	Cuttack	Odisha	6,06,007	6,68,710	1905824.48
114	Bhubaneswar	Odisha	8,37,321	9,23,958	2633281.23

Sr. No.	City	State	Population (2011)	Population (2020 est.)	UCO Potential (in litres)
115	Berhampur (District Ganjam)	Odisha	3,56,598	3,93,495	1121460.97
116	Puri	Odisha	2,01,026	2,21,826	632204.37
117	Rourkela	Odisha	3,60,000	3,97,249	1132159.88
118	Amritsar	Punjab	11,32,761	12,49,967	3562407.11
119	Jalandhar	Punjab	8,62,196	9,51,407	2711510.33
120	Ludhiana	Punjab	16,18,879	17,86,384	5091194.04
121	Bathinda	Punjab	13,88,525	15,32,195	4366756.38
122	Patiala	Punjab	4,06,192	4,48,221	1277428.57
123	Alwar	Rajasthan	4,61,618	5,09,381	1451737.17
124	Chittaurgarh	Rajasthan	1,16,406	1,28,450	366083.90
125	Jaisalmer	Rajasthan	65,471	72,245	205899.00
126	Kota	Rajasthan	10,01,694	11,05,339	3150216.00
127	Nagaur	Rajasthan	1,10,797	1,22,261	348444.22
128	Pali	Rajasthan	2,29,956	2,53,749	723185.99
129	Sawai Madhopur	Rajasthan	1,21,106	1,33,637	380864.87
130	Bikaner	Rajasthan	6,44,406	7,11,082	2026585.06
131	Ajmer	Rajasthan	5,42,321	5,98,435	1705539.11
132	Udaipur	Rajasthan	4,51,100	4,97,775	1418659.23
133	Jodhpur	Rajasthan	10,56,191	11,65,475	3321602.99
134	Jaipur	Rajasthan	30,46,189	33,61,377	9579924.93
135	Vellore	Tamil Nadu	5,04,079	5,56,236	1585272.28
136	Tiruppur	Tamil Nadu	24,79,052	27,35,559	7796342.27
137	Chennai	Tamil Nadu	70,88,000	78,21,393	22290970.09
138	Coimbatore	Tamil Nadu	16,01,438	17,67,138	5036344.04
139	Madurai	Tamil Nadu	10,17,865	11,23,183	3201071.99
140	Salem	Tamil Nadu	8,29,267	9,15,071	2607952.30
141	Kancheepuram	Tamil Nadu	14,41,829	15,91,015	4534391.52
142	Thiruvallur	Tamil Nadu	37,28,104	41,13,850	11724471.61
143	Thoothukkudi	Tamil Nadu	2,37,830	2,62,438	747948.85
144	Tirunelveli	Tamil Nadu	4,73,637	5,22,644	1489535.58
145	Viluppuram	Tamil Nadu	96,253	1,06,212	302704.96
146	Hyderabad	Telangana	68,09,970	75,14,595	21416596.73
147	West Tripura	Tripura	17,25,739	19,04,301	5427256.83
148	Gautam Buddha Nagar	Uttar Pradesh	16,48,115	18,18,645	5183138.00
149	Mathura	Uttar Pradesh	4,41,894	4,87,617	1389707.38
150	Varanasi	Uttar Pradesh	12,01,815	13,26,166	3779574.24
151	Kanpur Nagar	Uttar Pradesh	45,81,268	50,55,290	14407577.31
152	Bareilly	Uttar Pradesh	9,03,668	9,97,170	2841935.15
153	Lucknow	Uttar Pradesh	28,17,105	31,08,590	8859481.28
154	Meerut	Uttar Pradesh	15,24,908	16,82,690	4795665.72

Sr. No.	City	State	Population (2011)	Population (2020 est.)	UCO Potential (in litres)
155	Allahabad	Uttar Pradesh	11,12,544	12,27,659	3498826.90
156	Agra	Uttar Pradesh	15,85,704	17,49,776	4986862.36
157	Aligarh	Uttar Pradesh	8,74,408	9,64,883	2749915.71
158	Firozabad	Uttar Pradesh	6,03,797	6,66,272	1898874.28
159	Ghaziabad	Uttar Pradesh	17,29,000	19,07,899	5437512.32
160	Azamgarh	Uttar Pradesh	1,16,165	1,28,185	365325.98
161	Bahraich	Uttar Pradesh	1,86,223	2,05,491	585650.58
162	Ballia	Uttar Pradesh	1,04,424	1,15,229	328401.84
163	Barabanki	Uttar Pradesh	1,46,831	1,62,024	461767.13
164	Bijnor	Uttar Pradesh	1,15,381	1,27,319	362860.39
165	Budaun	Uttar Pradesh	3,69,221	4,07,424	1161158.90
166	Bulandshahar	Uttar Pradesh	2,35,310	2,59,657	740023.73
167	Ghazipur	Uttar Pradesh	1,21,136	1,33,670	380959.22
168	Gonda	Uttar Pradesh	1,22,164	1,34,804	384192.17
169	Gorakhpur	Uttar Pradesh	6,73,446	7,43,127	2117912.62
170	Hardoi	Uttar Pradesh	1,36,851	1,51,011	430381.14
171	Jaunpur	Uttar Pradesh	1,80,362	1,99,024	567218.39
172	Jhansi	Uttar Pradesh	5,05,693	5,58,017	1590348.13
173	Kheri	Uttar Pradesh	25,017	27,606	78675.68
174	Kushinagar	Uttar Pradesh	22,214	24,512	69860.55
175	Moradabad	Uttar Pradesh	8,89,810	9,81,878	2798353.29
176	Muzaffarnagar	Uttar Pradesh	4,95,543	5,46,817	1558427.51
177	Pratapgarh	Uttar Pradesh	32,09,141	35,41,190	10092390.81
178	Rae Bareli	Uttar Pradesh	1,91,056	2,10,825	600849.83
179	Saharanpur	Uttar Pradesh	7,05,478	7,78,474	2218649.69
180	Sitapur	Uttar Pradesh	1,77,351	1,95,701	557749.13
181	Sultanpur	Uttar Pradesh	1,07,640	1,18,777	338515.80
182	Unnao	Uttar Pradesh	1,77,658	1,96,040	558714.61
183	Dehradun	Uttarakhand	5,78,420	6,38,269	1819066.44
184	Udham Singh Nagar	Uttarakhand	16,48,902	18,19,513	5185613.03
185	Murshidabad	West Bengal	44,019	48,574	138434.85
186	South Twenty Four Parganas	West Bengal	81,61,961	90,06,476	25668457.75
187	Nadia	West Bengal	51,67,601	57,02,291	16251529.25
188	Paschim Medinipur	West Bengal	59,13,457	65,25,320	18597163.25
189	North Twenty Four Parganas	West Bengal	1,00,09,781	1,10,45,490	31479645.73
190	Barddhaman	West Bengal	3,47,016	3,82,922	1091326.65
191	Haora	West Bengal	10,77,075	11,88,520	3387280.84
192	Hugli	West Bengal	55,19,145	60,90,209	17357095.96
193	Kolkata	West Bengal	44,96,694	49,61,965	14141601.51
194	Bankura	West Bengal	1,37,386	1,51,601	432063.66

Sr. No.	City	State	Population (2011)	Population (2020 est.)	UCO Potential (in litres)
195	Birbhum	West Bengal	35,02,404	38,64,797	11014670.26
196	Darjeeling	West Bengal	1,32,016	1,45,676	415175.61
197	Jalpaiguri	West Bengal	1,69,002	1,86,489	531492.46
198	Maldah	West Bengal	3,24,237	3,57,786	1019689.23
199	Purba Medinipur	West Bengal	50,95,875	56,23,144	16025958.98
200	Uttar Dinajpur	West Bengal	30,07,134	33,18,281	9457101.31
201	Eluru	Andhra Pradesh	2,17,876	2,40,420	685195.74
202	Kadapa	Andhra Pradesh	3,44,893	3,80,579	1084650.05
203	Kakinada	Andhra Pradesh	3,84,128	4,23,874	1208039.75
204	Machilipatnam	Andhra Pradesh	2,19,892	2,42,644	691535.83
205	Yupia	Arunachal Pradesh	1,76,573	1,94,843	555302.41
206	Changlang	Arunachal Pradesh	1,48,266	1,63,607	466280.05
207	Tezu	Arunachal Pradesh	1,45,726	1,60,804	458292.03
208	Along	Arunachal Pradesh	1,12,274	1,23,891	353089.22
209	Dhubri	Assam	63,338	69,892	199190.95
210	Tezpur	Assam	1,02,505	1,13,111	322366.80
211	Silchar	Assam	1,72,830	1,90,713	543531.09
212	Barpeta	Assam	16,93,622	18,68,861	5326252.45
213	Goroimari	Assam	1,34,387	1,48,292	422632.14
214	Bihar Sharif	Bihar	3,69,972	4,08,253	1163520.71
215	Motihari	Bihar	1,26,158	1,39,212	396752.85
216	Chhapra	Bihar	2,01,598	2,22,457	634003.24
217	Betia	Bihar	1,32,209	1,45,889	415782.57
218	Hajipur	Bihar	1,47,126	1,62,349	462694.87
219	Katihar	Bihar	2,40,565	2,65,456	756550.12
220	Ambikapur	Chhattisgarh	1,23,173	1,35,918	387365.36
221	Naila Janjgir	Chhattisgarh	16,19,707	17,87,298	5093798.01
222	Rajnandgaon	Chhattisgarh	15,37,133	16,96,180	4834111.98
223	Jagdalpur	Chhattisgarh	5,55,000	6,12,426	1745413.15
224	Silvassa	Dadra Nagar Haveli	98,265	1,08,432	309032.47
225	Daman	Daman & Diu	1,91,173	2,10,954	601217.78
226	Diu	Daman & Diu	52,076	57,464	163773.22
227	Bhuj	Gujarat	2,13,514	2,35,606	671477.74
228	Palanpur	Gujarat	1,41,532	1,56,176	445102.37
229	Godhra	Gujarat	1,43,644	1,58,507	451744.37
230	Mehsana	Gujarat	1,84,991	2,04,132	581776.08
231	Surendranagar	Gujarat	3,97,000	4,38,077	1248520.76

Sr. No.	City	State	Population (2011)	Population (2020 est.)	UCO Potential (in litres)
232	Morbi	Gujarat	1,94,947	2,15,118	613086.59
233	Hisar	Haryana	3,01,249	3,32,419	947394.53
234	Bhiwani	Haryana	1,96,057	2,16,343	616577.42
235	Jind	Haryana	1,67,592	1,84,933	527058.16
236	Sirsa	Haryana	1,82,534	2,01,421	574049.09
237	Yamuna Nagar	Haryana	2,16,628	2,39,042	681270.92
238	Panipat	Haryana	2,95,970	3,26,594	930792.67
239	Dharamshala	Himachal Pradesh	53,543	59,083	168386.77
240	Mandi	Himachal Pradesh	26,422	29,156	83094.25
241	Solan	Himachal Pradesh	39,256	43,318	123455.75
242	Anantnag	Jammu & Kashmir	1,59,838	1,76,376	502672.70
243	Baramulla	Jammu & Kashmir	10,15,503	11,20,577	3193643.76
244	Kupwara	Jammu & Kashmir	70,000	77,243	220142.20
245	Udhampur	Jammu & Kashmir	2,15,213	2,37,481	676820.90
246	Leh	Ladakh	30,870	34,064	97082.71
247	Jamshedpur	Jharkhand	6,29,659	6,94,810	1980207.38
248	Dhanbad	Jharkhand	11,62,472	12,82,753	3655844.89
249	Giridih	Jharkhand	1,43,529	1,58,380	451382.71
250	Daltonganj	Jharkhand	1,20,325	1,32,775	378408.72
251	Hazaribag	Jharkhand	1,53,599	1,69,492	483051.74
252	Mangalore	Karnataka	4,84,785	5,34,946	1524594.80
253	Bellary	Karnataka	4,10,445	4,52,914	1290803.78
254	Gulbarga	Karnataka	5,33,587	5,88,797	1678071.65
255	Bijapur	Karnataka	3,27,427	3,61,306	1029721.43
256	Kakkanad	Kerala	25,531	28,173	80292.15
257	Palakkad	Kerala	1,30,955	1,44,505	411838.88
258	Kannur	Kerala	2,32,486	2,56,541	731142.56
259	Morena	Madhya Pradesh	2,00,483	2,21,227	630496.69
260	Jhabua	Madhya Pradesh	35,753	39,452	112439.20
261	Rewa	Madhya Pradesh	2,36,516	2,60,988	743816.46
262	Ratlam	Madhya Pradesh	2,64,914	2,92,325	833125.01
263	Sagar	Madhya Pradesh	3,70,296	4,08,610	1164539.65
264	Alibag	Maharashtra	20,743	22,889	65234.42
265	Sangli	Maharashtra	28,22,143	31,14,149	8875325.23
266	Buldhana	Maharashtra	25,86,251	28,53,850	8133471.18
267	Bhandara	Maharashtra	91,845	1,01,348	288842.29

Sr. No.	City	State	Population (2011)	Population (2020 est.)	UCO Potential (in litres)
268	Lamphelpat	Manipur	2,21,422	2,44,332	696347.51
269	Porompat	Manipur	4,56,113	5,03,307	1434424.55
270	Thoubal	Manipur	4,22,168	4,65,850	1327671.31
271	Shillong	Meghalaya	1,43,229	1,58,049	450439.24
272	Tura	Meghalaya	74,858	82,604	235420.07
273	Lunglei	Mizoram	57,011	62,910	179293.24
274	Champhai	Mizoram	32,734	36,121	102944.78
275	Dimapur	Nagaland	2,54,674	2,81,025	800921.35
276	Mon	Nagaland	2,50,260	2,76,154	787039.81
277	Chhatrapur	Odisha	22,027	24,306	69272.46
278	Baripada	Odisha	1,16,874	1,28,967	367555.71
279	Balasore	Odisha	1,44,373	1,59,311	454037.00
280	Khordha	Odisha	1,20,204	1,32,641	378028.18
281	Puducherry	Puducherry	13,94,467	15,38,752	4385443.31
282	Gurdaspur	Punjab	77,928	85,991	245074.88
283	Firozpur	Punjab	1,10,313	1,21,727	346922.09
284	Sangrur	Punjab	88,043	97,153	276885.42
285	Tarn Taran Sahib	Punjab	66,847	73,764	210226.37
286	Moga	Punjab	2,98,432	3,29,311	938535.38
287	Malkajgiri	Telangana	4,13,541	4,56,330	1300540.36
288	Nalgonda	Telangana	1,65,328	1,82,434	519938.14
289	Nizamabad	Telangana	3,11,152	3,43,347	978538.36
290	Khammam	Telangana	3,13,504	3,45,942	985935.14
291	Mahbubnagar	Telangana	1,57,733	1,74,054	496052.71
292	Warangal	Telangana	8,30,281	9,16,190	2611141.22
293	Suryapet	Telangana	1,05,250	1,16,140	330999.52
294	Rampur	Uttar Pradesh	3,25,248	3,58,901	1022868.71
295	Mau	Uttar Pradesh	2,78,745	3,07,587	876621.96
296	Balrampur	Uttar Pradesh	81,054	89,441	254905.80
297	Purulia	West Bengal	1,21,436	1,34,001	381902.69
298	Cooch Behar	West Bengal	1,78,670	1,97,157	561897.24
299	Balurghat	West Bengal	1,51,416	1,67,083	476186.45
300	Alipurduar	West Bengal	1,27,342	1,40,518	400476.40

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