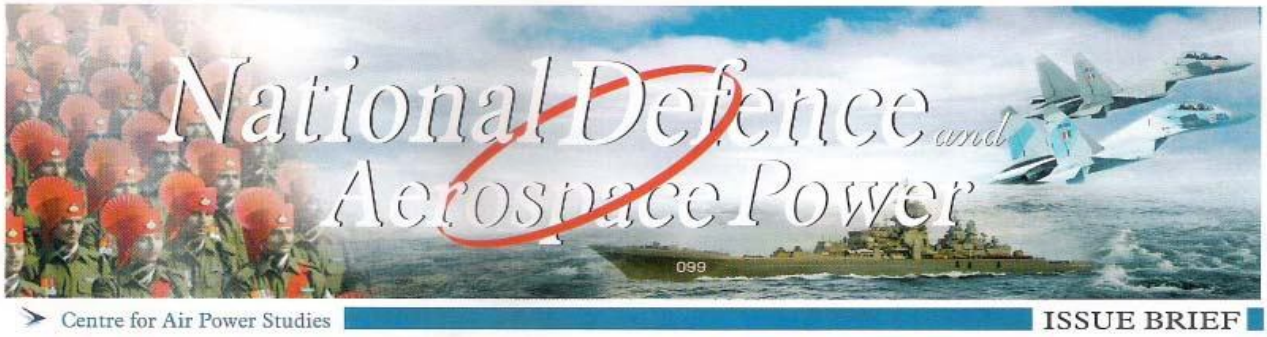

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AVIATION ECONOMICS TO AGRARIAN TREPIDATION: CAN BIO-JET PROVIDE A BALANCED SOLUTION?

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In January 2019, the Ministry of Consumer Affairs, Food and Public Distribution (Bureau of Indian Standards) has notified a new national standard for Bio-jet fuel. The new standards for aviation synthetic fuel would permit the use of surplus bio-mass and agroforestry products like non-edible vegetable oil, sugar, alcohol, etc for manufacturing green Aviation Turbine Fuel (ATF). If exploited fully, it has the potential to boost the aviation sector while concurrently aiding the agrarian economy. Biofuels (including bio-jet) are derived from renewable biomass resources and wastes such as Plastic, Municipal Solid Waste(MSW), waste gases etc.They seek to provide a higher degree of national energy security in an environmentally friendly and sustainable manner. These new fuels would supplement conventional energy resources, reduce India's dependence on imported fossil fuels and satisfy the energy needs of urban and vast rural population.

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Earlier on January 03, 2019, while delivering the inaugural address at the 106th Indian Science Congress at Jalandhar, Prime Minister Shri Narender Modi had said,[1] "2018 was a good year for Indian science, amongst our achievements this year are; the production of aviation grade bio-fuel, machine for visually impaired, device for diagnosis of cervical cancer, TB, dengue,…..". The PM also said that he would like to suffix a few words to the legendary slogan coined by former Prime Minister, Shri Lal Bahadur Shastri. The historic slogan should now read, 'Jai Jawan, Jai Kisan, Jai Vigyan, Jai Anusandghan'. He, thus directed the scientific community and researchers to focus on innovations and inclusive technologies that bring about a positive change while providing solutions to local needs and condition.

To ensure fulfilment of the Government's vision there is a need to work towards developing a roadmap that enables smooth commercialisation of bio-jet fuel in India. A policy framework that leverages the research into a sustainable industrial product is required urgently to catalyse, harness and manage change by converging the efforts of many functionaries[2] towards achieving techno-commercial success. This brief re-count the contribution of various departments and

ministries of the Government of India, towards this national capability demonstrative project and suggests a way forward. The success of this action plan would not only bring prosperity to the farming community but also benefit the aviation sector in near future.

Economics of Indian Aviation Sector

Indian aviation sector is soaring to position itself as the 3rd largest aviation market by 2024,[3] with more passengers and aircraft in air just below China and America. This is when less than 1% of the country's population travels by air,[4] indicating potential for high growth. However, in-spite of these positives, the airlines industry is facing an existential crisis, primarily due to high fuel costs, low ticket prices and clogged airport infrastructure.[5] Aviation Jet fuel makes up to almost 40% of the expenses of Indian airline operators and any fluctuation in price directly affects their operating margins. The revenue budget of the Indian Air Force is also adversely affected by changes in ATF price. Recently, on January 01, 2019, the state-owned oil companies reduced the price of aviation fuel by about 14.7% to infuse much needed relief to cash-strapped airlines. However, will these efforts suffice to bring the aviation sector out of the red? Can the use of bio-jet fuel provide any sustainable solution?

There would also be a potential strategic gain for India as bio-fuels would help to reduce the nation's dependence on imported crude and conserve forex to a certain extent. Another important advantagewould be its direct contribution to agrarian economy. An increase in demand of bio-jet fuel will support an ecosystem for cultivation and processing non-edible vegetable/ tree-based oil across the country.

On August 27, 2018, Spicejet flew the first bio-jet fuelled civil flight in India. According to CMD of the company, Mr Ajay Singh, bio-jet fuel is more efficient and enhances engine performance by 15-20%.[6] Although, theoretically, this figure may appear exaggerated, but a similar opinion was were expressed by researchers from IIT, Kanpur and IISc, Bengaluru, who had conducted the initial combustion efficiency test on the Indian bio-jet fuel in 2013. More recently, quality checks conducted by CEMILAC at oil refineries show[7] that it is lighter, i.e. has lower density than conventional ATF[8] and contains more energy per kg i.e. has higher specific energy density;[9] thus, it delivers more power per gram of fuel. The bio-jet fuel also has extremely low sulphur content, which would not only improve efficiency but also help in extending the life of aeroengines and fuel-soaked components by reducing corrosion. Simultaneously, increased use of bio-jet fuel, proportionally reduces the carbon footprint of the sector, which is required to meet the ICAO's obligation in the next few years.

Moreover, there would also be a potential strategic gain for India as bio-fuels would help to reduce the nation's dependence on imported crude and conserve forex to a certain extent. Another important advantage would be its direct contribution to agrarian economy. An increase in demand of bio-jet fuel will support an ecosystem for cultivation and processing non-edible vegetable/ tree-based oil across the country. A path-breaking single-step indigenous technology developed by CSIR-IIP, Dehradun converts Tree Based Oil (non-edible) into bio-jet and bio-diesel. A kilogram of oil makes about 300 millilitres of bio-jet and 350 millilitres of bio-diesel. The Indian aviation industry consumes over 7.6 Million Metric Tonnes (MMT) of ATF; even a 5% bio-jet fuel blend would require over 0.38 million litres of fuel or 3.4 MMT of oil seeds annually.[10] Experts from CSIR-IIP believe, the long-term socio-economic gains, improved performance and strategic outreach of bio-jet fuel would surpass any notional financial losses[11] which may appear presently.

The Agrarian Trepidation

Since the last few months, the issue of farmers distress has been central to many discussions. Most scholars attribute this to the increasingly fragile agrarian ecosystem that includes, unpredictable seasonal weather condition, dwindling water resource, increasing input cost and volatility in procurement price of farm yield. The government has been working on various plans to offset rural distress. For years the

conventional approach towards the crisis has been; increasing the Minimum Support Price of produce or granting waivers to farm loan. However, time has established that these measures have limited success, but with the successful demonstration of biofuel technologies, enforcement of environmental norms, and the promulgation of the new national standards for Bio-jet fuel, a process to generate sustained demand for biofuels can be put in place. These actions will create new avenues for generating income from farm waste and non-edible vegetable oil seeds and help augment agrarian earnings.

National Bio-fuel Policy

Over the last decade, the Government has undertaken multiple interventions to promote biofuels in the countrythrough structured programmes like Ethanol Blended Petrol Programme, National Biodiesel Mission, Biodiesel Blending Programme. The new National Bio-fuel Policy,[12] 2018 came into effect on May 16, 2018 and as part of its scope also includes development of advanced 'Drop-in' fuels for use as Jet fuel in aircraft.

The policy recommends encouraging farmers to grow various varieties of oil seeds on their marginal land, as intercrop and/ or as second crop under non-rain fed condition. Further, the policy suggests that the state and local functionaries should develop suitable supply chain mechanism for feedstock collection with price support guarantee. As regards fiscal incentives, the policy envisages incentivising advanced biofuel industry with tax credits, differential pricing and viability gap funding by the National Biofuel Coordination Committee. This new policy initiative may rejuvenate the oil-seed production in the country. However, encouraging the farmers for cultivating oil-seeds for production of bio-fuel comes under preview of Ministry of Agriculture and Farmers Welfare (MoA&FW), Government of India.

National Mission for Sustainable Agriculture

The National Mission for Sustainable Agriculture (NMSA) was launched in the year 2014 by MoA&FW, to enhance agricultural productivity especially those in rainfed areas by focusing on integrated farming, efficiency in use of water, soil health management and synergizing efforts towards conserving agrarian resources. Thereafter, the Sub-Mission on Agroforestry (SMAF) was started in 2016-17 with an aim to encourage tree plantation along farmland. Such trees species were selected which could enriched soil and whose produce would provide complementary economic gains to farmers. The mission then covered over 3.62 lakh hectare of forest and non-forest land,[13] this year the targets is to include another 0.92 lakh hectare into the scheme. Initially the NMSA policy focused only on bamboo plantation, however since last two years various other varieties of forest plants having medicinal/ commercial value have been added to the select list. Now, with the establishment of the new standards and demands from aviation industry, there is a requirement to enthuse the farmers to also plant oil seed trees especially those with short gestation period, yield of which can be used to manufacture Bio-jet fuel. Few potential oilseeds which could be used for producing bio-jet fuel are listed in Table1-[14]

TABLE 1: LOCALLY AVAILABLE OIL SEEDS IN INDIA

Sl. No	Species	Yield, (Ton/hectare)	Oil Content %	Region
1	Jatropha Curcas	2.5-4	30-42	Central and southern states
2	PongamiaPinnata	4-12	27-42	Western, central and southern states
3	Wild Apricot	2-4	30	J &K, Himachal,
4	Simarouba	1-1.3	60-70	Western, central and southern states
5	Neem	2-4	30	Pan India except north east
6	Jojoba	1-1.15	50	Western states

Bio-jet Fuel Standards

Since year 2017, the Indian Air Force has been working with the Ministry of Petroleum & Natural Gas's working group on biofuel and Council of Scientific & Industrial Research- Indian Institute of Petroleum (CSIR-IIP) towards development and testing of alternate bio-jet fuel. This was in-line with India's effort to reduce its dependence on imported crude and the successful adaptation by US AF towards bio-jet fuel. The first military aircraft with bio-jet fuel blend flew on December 17, 2018. However, the major limitation towards full scale use of bio-jet fuel by IAF was the non-availability of concurrent Indian standards for Bio-jet fuel.

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Aviation Turbine Fuel, Kerosene type, Jet A-1 fuel, is widely used fuel for military aircraft of the IAF. Its specifications are defined in Indian Standard IS: 1571 issued by the Bureau of Indian Standard (BIS). ATF predominantly consists of refined hydrocarbons derived from conventional sources including crude oil, natural gas liquid condensates, heavy oil, oil shale and oil sands. Use of synthesized fuel components from alternate sources like bio-mass, TBO, alcohol, etcis a recent departure and envisages to decrease net lifecycle carbon emissions of aircraft. Most international standards like Def Stan 91-91 (UK) and ASTM 1655 (USA), AFQRJOS (IATA) have permitted the blending of synthetic components derived from non-petroleum source to kerosene base ATF. However, the Indian standards did not recommend use of such 'drop-in's, as the specific guidance required to test the synthesized hydrocarbons from unconventional sources werebeyond the scope of the Indian standards. Therefore, revision of Indian standards was required for commercial success of the Bio-jet fuel project.

The Indian standard for Jet A-1 was last updated in 2016-17 but was due for routine revision as concurrent international standards had all been revised. On February 01, 2018, the BIS's sectional committeeon 'Petroleum and Their Related Products of Synthesis or Biological Origin Sectional Committee,' PCD 3, circulated the first draft of revised standards for conventional ATF (kerosene type, Jet A-1) for comments from all stakeholder. On the IAF's insistence to include bio-jet fuel in the main standards, a dedicated group of experts was tasked to prepare the draft for 'Alternate Jet Fuels' in-line with international standards with specific reference to indigenous technology. The expert group was called 'Panel for Bio-Jet Fuels' and included members from R&D institutes, oil refineries, test agencies and the IAF. The panel drafted a new standard incorporating references to all type of scientific processes including that of CSIR-IIP, for producing aviation range hydrocarbon. The standard defined the process and product specification for bio-jet fuel and test requirements specific to each process. A similar procedure was followed earlier in 2004 while defining the standards for bio-diesel.

The first draft of the standard was prepared within three months and presented by the panel at an especially convened meeting at IAF Headquarters on September 11, 2018. The meeting was attended by experts from the oil industry, DGCA, DGAQA, CEMILAC and users like IAF and Spice Jet. After detailed technical evaluation by scientist from oil refineries the draft was comprehensively reviewed by the regulators. The final draft was presented to the BIS's sectional committee on October 05, 2018 and approved thereafter. This new standard has now been titled as 'Aviation Turbine Fuels, Containing Synthesized Hydrocarbons,' and codified as IS 17081:2019. The standard has been gazette notified on January 16, 2019, thereby paving the way for commercial use of bio-jet fuel by civil as well as military aircraft. According to Dr YP Rao the convener of the sectional committee of BIS, use of bio-jet fuel may soon be a regulatory compulsion especially in view of efforts to reduce global warning by limiting CO^2 emission from the aviation sector and enforcement of CORSIA[15]regulation. The new Indian national

standards would help in indigenous production of bio-ATF of internationally accepted quality.

Integrating the Vision Statement

The January 2019, notification by BIS has the potential to connect the farming sector to the aviation sector. With the approval of the new Indian standards, IS 17081:2019 'Aviation Turbine Fuels, Containing Synthesized Hydrocarbons,' it is now possible to commercially manufacture bio-jet fuel for use in aircraft. Concurrently, the indigenous technology for the production of the bio-jet fuel from vegetable oil developed seven years ago, has also been proven for commercialisation with the efforts of the IAF, oil refineries and CSIR-IIP (a maiden collaborative effort in the field of aviation by the institute). However, there is still a need to establish wide-spread supply chains for collection of extremely large quantities of oil seeds which is the feedstock for production of bio-jet fuel. For this, tribal and marginal farmers will have to be guided and enthused to cultivate/ collect non-edible oil seeds. Departments associated with agroforestry, like NMSA,MoA&FW, etc would have to be the prime movers in this mission. The IAF, on its part, has offered to provide the demand side support for this national capability building demonstrative project. Similar commitments from the civil aviation sector would make this project successful. Concurrent financial assistance is required from the government for the initial phase, in form of viability gap funding, to encourage the user to switch to this new renewable 'drop-in' fuel.

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[7] Independent quality and checks conducted by Centre for Military Airworthiness and Certification at Jamnagar and Panipat oil refineries.

[8] Density (at 15°C) in Kg/m^3 - 0.775 for Bio-jet against 0.790 for ATF

[9] Specific Energy in MJ/Kg – 44.0 for Bio-jet against 42.8 for ATF

[10] Assuming 35-40% oil content in seeds and a distillation factor of 30-35% of bio-jet from non-edible tree-based oils.

[11] CSIR-IIP lab-based distillation plant produces bio-jet at 1.5 times the cost of commercial ATF and biodiesel without adjusting for tax

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[15]Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), is an emission mitigation approach for the global airline industry, developed by theInternational Civil Aviation Organization(ICAO). It addresses emissions from international air travel.

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