Agricultural Aviation in India : A Perspective with Accent on Aero-Medical Problems

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A historical and general review of agricultural aviation with emphasis on activity in India and special aeromedical problems associated with this form of low speed low level flying is presented. It is concluded that an extensive survey of operations is urgently needed, and special watch be kept by the aeromedical authorities for short and long term effects of exposure to pesticides. Some recommendations to this end are also made.

THE use of aircraft for agricultural purposes had its origin more than 50 years ago. The first documented case of an aircraft having been used for pest control was reported in the March 1922 issue of the *National Geographic* wherein a Curtiss JN6 (Jenny) aircraft was fitted with a "purse string" bag full of lead arsenate dust for application on catapa trees. The USSR and New Zealand were the other pioneers and, to date, remain the major users of Agro aviation apart from some 50 other countries, India included. Since the early days, aircraft have gradually increased their usefulness to many phases of agricultural production, particularly plant protection and pest control.

In India, the use of Tiger Moth aircraft for aerial spraying dates back to the late fifties after which Beaver aircraft were acquired under the Colombo Plan. Subsequently, Piper Pawnee, Bumble Bee, and Bell helicopter were inducted into service, along with the indigenously produced Basant HA-31 aircraft, the last named being the backbone of operations today.

The advantages of aerial applications are many and include speed of operations, and the ability to apply materials where and when ground means are impossible or impractical. The aerial application business in India is mainly public sector enterprise, the responsibility resting with the Directorate of Agricultural Aviation, under the Ministry of Agriculture. In addition, there are a few privately owned fixed and rotary wing aircraft of varying vintage available on contract basis.

Spread all over India, the operations include spraying of tea, coffee, rubber, cashew, sugarcane, mango, paddy, cotton, mustard and groundnut crops. The "Season" in the North is from July to September. In the period 1968 to 1980, area of cotton spraying has increased from a few thousand hectares to 1,36,500 hectares, and a three-fold increase in areas cultivated with rape and mustard seed, has also been registered. Certain socio-economic and political factors stand in the way of further expansion of the field of endeavour, apart from the ubiquitous increase in operating costs.

Basant aircraft typifies the Aerodynamic characteristics of a fixed wing aircraft specifically designed for Agaviation. It is a single seat, strut braced low wing (dihedral 5°) monoplane of metal/fabric/wood construction fitted with a 208 gallon capacity hopper between the engine and cockpit for liquid/solid applications. The undercarriage is fixed and the seat is attached to the floor of the cockpit and stressed to withstand upto 40 G. Facility exists for stowing a parachute under the seat It has a GQ type of harness fitted with a QRB. Its cruising speed is 94 mph and service ceiling 10,000 ft. Endurance in the agrirole is 41 min. Aural and visual stall warnings are set to trigger off at 5 to 10 mph above stall speed, in straight or turning flight. This is an important requirement as a number of accidents occur during turns and on application runs. An interesting feature of the design is the provision of sharp wedges on the undercarriage struts to cut any high tension or other cables accidentally encountered.

Flight Planning, Application Techniques and Meteorological Factors Related to Aerial Application

It is not within the scope of this paper to present a detailed account of the above factors, and each will be discussed only briefly.

Flight Planning : A request from the interested farmer is processed through the village administrative channels to the Directorate of Agricultural Aviation via the State and Central agricultural administrations. A survey of pests and their insecticide resistance is done and, rough landing strips are hewn out of the terrain in the proximity of the fields to be sprayed. Ground support for operations includes transport and storage of fuel, water, chemicals, labour requirements (flagmen), sheds, tents and notification to the nearest medical facility to cater for any accidental poisonings/crash etc. The choice of flight patterns for application runs for a given job will depend on the type of terrain, the obstacles, and the physical constitution of the chemical being applied. In particular, where 2 aircraft in simultaneous operation, as for the application for top dressing or work involving large volumes, the race course pattern is preferred. The basic principle of application is to put the material where it is most effective and with minimum waste/drift. Depending on whether solid or liquid formulations are to used, particle size, density, application volumes e various means are available for optimal utilisati per flight.

Flagmen : These are the locally employed labo whose job is essentially to mark out application flig path by means of holding 1 sq m size flags (oran or yellow). They are spread out linearly over t length of the field (at times ten miles) separated one swath width from the next row of flagmen. C completion of one pass, they are "rotated" and ta up new positions. Red flags are displayed prom nently near high tension cables, and other obstructio Balloons, windsocks, smoke bombs and colour dusts can also be used for the purpose. More soph sticated flight path guides include electronic navig tional equipment like LORAC, LORAN and DECC systems, the last named being most favoured, co sisting essentially of 2 mobile ground stations th activate a RIGHT-LEFT guidance meter (on boar for the pilot to follow.

Atmospheric Conditions : Up-to-date meteorolo gical data is very important for safe and effecti operations ; wind velocities and directions effect n only operational flight patterns but also the decision as to whether a certain type of application should b performed or not. Winds displace swath patterns proportion to increase in velocity, and also affe aircraft handling, specially near the ground. Hum dity by reducing air density can cause problems fo the unwary pilot in 2 ways ; firstly, it reduces max mum engine power because reduced air mass pe unit volume is drawn into the carburettor, an secondly it reduces lift, for a given wing configura tion, thereby affecting ability to get airborne, o reducing rate of climb. Increased surface temperatur also reduce air density in the flight environment.

Ground Effect : Special mention should be mad of this phenomenon that occurs when an aircraft i flown close to the ground at a height of one win span above the ground. The ground reflection o the air-stream or downwash from the wing results i a rapidly lowered induced drag as the aircra approaches the ground, and therefore, lower powe requirements to maintain altitude. On take off, th reverse is true, it is possible for an aircraft to ge airborne but it is unable to climb out of the "ground effect" before running out of runway. While ground effect can be of benefit while landing, taking off with an overloaded aircraft can be hazardous to the unwary pilot.

Aeromedical Problems : These will be discussed under the following headings :—

a) Administrative
b) Flying clothing
c) Environmental factors
d) Noise
e) Pesticide Toxicity
f) Pilot fatigue
g) Repeated "G" loads
h) Accident data

Administrative : The pilot's task, as overall in-charge of operations, entails meticulous planning and execution. There are the usual "head-aches" associated with tying up numerous loose ends such as air-field facilities, medical arrangements, collection of meteorological data etc. Banga[2] has described these in a paper. The most modern management concepts need be applied for optimum cost-effectivisation.

Flying Clothing : In the absence of airtight cockpits, the need for proper equipment becomes imperative. There are many lacunae in this sphere. No indigenous masks are available. The imported ones (akin to KM-19 but without the rubber bag) do not last, or are simply not available. Aircrew dip their faces into the mask (which is hung loosely around the neck) when flying through the swath. They use motorcycle crash helmets and often fly in shorts thus exposing themselves to potential absorption of chemicals through the skin. Anti - glare glasses are also of varied types, presenting different degrees of distortion.

Environmental Factors : Most flying is done early morning or late noon. This is mainly to avoid high environmental temperatures. This upsets the quality and quantity of sleep predisposing to fatigue. Ignorance about proper electrolyte and fluid balance, the urge to get on with the job and lack of facilities also add up to avoidable and induced pilot fatigue. Strong winds and vagaries of temperature and humidity also affect aircraft handling characteristics and produce fatigue.

Noise : No survey of noise in and around the Basant cockpit has been done. In view of the flying schedules and lack of proper helmets or ear plugs, noise induced deafness must be a common potential if not prevalent condition. This aspect needs attention more so because many pilots return to active IAF duty. It will, thus, be of interest to study audiometry records of Agaviation pilots.

Table — I

List of Chemicals that are Aerially Sprayed

Chlorinated Hydrocarbons	Organophosphorus	Fungicides
1 Lindane	1. Malathion 96% ULV and 50%	1. Copper Oxychloride
2. Toxaphane	2. Feninthrothion	2. Zuram
3. Endosulfan	3. Dimethoate	3. Hinosen
4. B H C	4. Oxydemetho-methyl	4. Sulphur 85% micronised dust and 80% WP.
	5. Phosphomidon	
	6. Carbaryl	
	7. Quinlphos	
	8. Monoerotoplos	
	9. Phenthroate	
	10. Phosalone	

Pesticide Toxicity : A list of commonly used pesticides is given in Table 1. Organophosphorus and organochlorine toxicities are well documented in literature but not of the newer chemicals. The lay press publishes stories of how toxic chemicals are dumped by western countries on the lesser developed ones, and India may be no exception. Though a fool proof system exists for screening of new chemicals prior to use in the country. Nag[6] informs of the need to study Agaviation aircrew on a longitudinal basis so as to introduce and implement better preventive measures. DDT and BHC have been banned in the USA, but still remain in the forefront of our war on pests. Record of toxicity cases related to Agaviation are not available nor are the accident data pertaining to such toxicity. Base levels of

Serum Cholinesterase need to be estimated in all crew at the onset of operations, along with periodic checks to obviate cumulative effects.

Pilot Fatigue : This has been long considered a primary factor associated with accident rates. Factors which contribute to fatigue are :—

a) Frequent early morning operations, thus interfering with pilot's rest.

b) Low speed low level flight, with many obstacles, and frequent turbulent weather.

c) Long working hours with multiple landings and take offs (upto 10 to 15 per hour).

d) Exposure to chemicals which can impair pilot's vision, increase drowsiness and interfere with vestibular function.

"G" Loads : Agaviation pilots are inclined to treat turns as undesirable loss of application time and are tempted to 'cut corners', thus subjecting themselves to a form of "low sustained G". This introduces an additional source of fatigue by the pilots themselves.

Accident Data : The accident rate for Agaviation in many countries is found to be the highest as compared to all commercial or industrial flying, and there is no reason to believe the situation to be any different in India. Since World War II, while all accident rates have decreased considerably, the agricultural aviation accident rates have retained their relative position to other forms of flying. In India, agricultural aviation accidents formed 9.9% of total civil aviation accidents during 1961-70 and 23.6% during 1971-80 giving an overall 16.92% for the 20 year period (1961-'80). 8.33% of all fatal civil aviation accidents during these 20 years have been in agricultural aviation.

Take off and landing operations account for the greatest number of Agaviation accidents, estimated in some studies to be as high as 60%, primarily due to poor strips and overloaded aircraft. Stalls in turns, aggravated by low level flight, inexperiance and obstructions such as high tension wires, telephone lines, terrain, trees etc are additional factors. Pilot error, with all its ramifications, accounts for 70 to 80% of data reported from India, USA, UK. New Zealand and Australia. Further broken down, 18 to 36% occur during landing, take off or taxying, 12 to 44% on account of collision with obstacles mentioned above, and 14 to 16% occur during the application runs (stalls, loss of control). Another survey[8] listing fewer categories found 22% accidents due to landing and take off, 8.6% at swath ends and 5.6% on approaches to the swath run.

Recommendations

Given this picture of the Agaviation operations in India, certain suggestions readily lend themselves to urgent application. These are :

1. An 'on the spot' evaluation of the operations by aeromedical experts.
2. Research, development and standardisation of indigenous flying clothing.
3. Indoctrination of aircrew regarding special hazards of their tasks.
4. Collection and evaluation of accident data.
5. Strict checks on pilots for Cholinesterase activity and noise induced deafness and periodic review.
6. Establishment of protocols for evaluation of effects of newer chemicals.
7. Establishment of feedback channels between user organisations and the Institute of Aviation Medicine, Bangalore.

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