Industry (UAPASTF) Response to Pesticide Regulators “State of the Knowledge” Review of Unmanned Aerial Vehicle (UAV) Use for Pesticide Application: Developing Best Practices for Safe and Effective Application of Pesticides Using Unmanned Aerial Spray Systems (UASS)

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Acknowledgement: Greg Watson and UAPASTF Best Management Practices Technical Team

Factor Driving Adoption of UAVs for Pesticide Application

Socioeconomical Factors

- Ageing and decreasing farming population.
- Migration to cities.
- Rising labor cost.

Technology Factors

- Safety to applicator/farmer, reduced exposure.
- More efficient and accurate application method compared to some alternatives such as backpack.
- Fits small size farms and difficult terrain (hills, paddies, wet fields).
- Remote sensing and variable rate spraying.
- Improvements and lower cost in the fields of electronics, optics, computer science, GPS, energy storage and others.

UAVs Have Replaced Mostly High Exposure and Less Accurate Application Methods in China

Battery Operational Back-Pack

Vacuum Pump

Gas Powered Pump-Large Hose

Hand Pump Back-Pack

UAV/UASS

2014
First launch
695 drones
200K ha treated

2016
6,000 drones
2.7MM ha treated

2018
Est. 30,000 drones
16.7MM ha treated

2020
115,000 drones 50MM ha treated

2021
200,000 drones
93MM ha treated

Oil Palm Bagworm Example in Malaysia: UAVs Becoming A New Method of Application That Provides Better Coverage and Less Exposure

Conventional Methods of Application Used

Airblast

Motorized Backpack

Trunk Injection

Airplane application possible, but too expensive

New tool being introduced, Commercial experiences needed

UAVs Can Complement Other Application Methods: i.e., Spot Applications, Borders, Sensitive Areas

1. UAV Complementing Ground Application on Trees

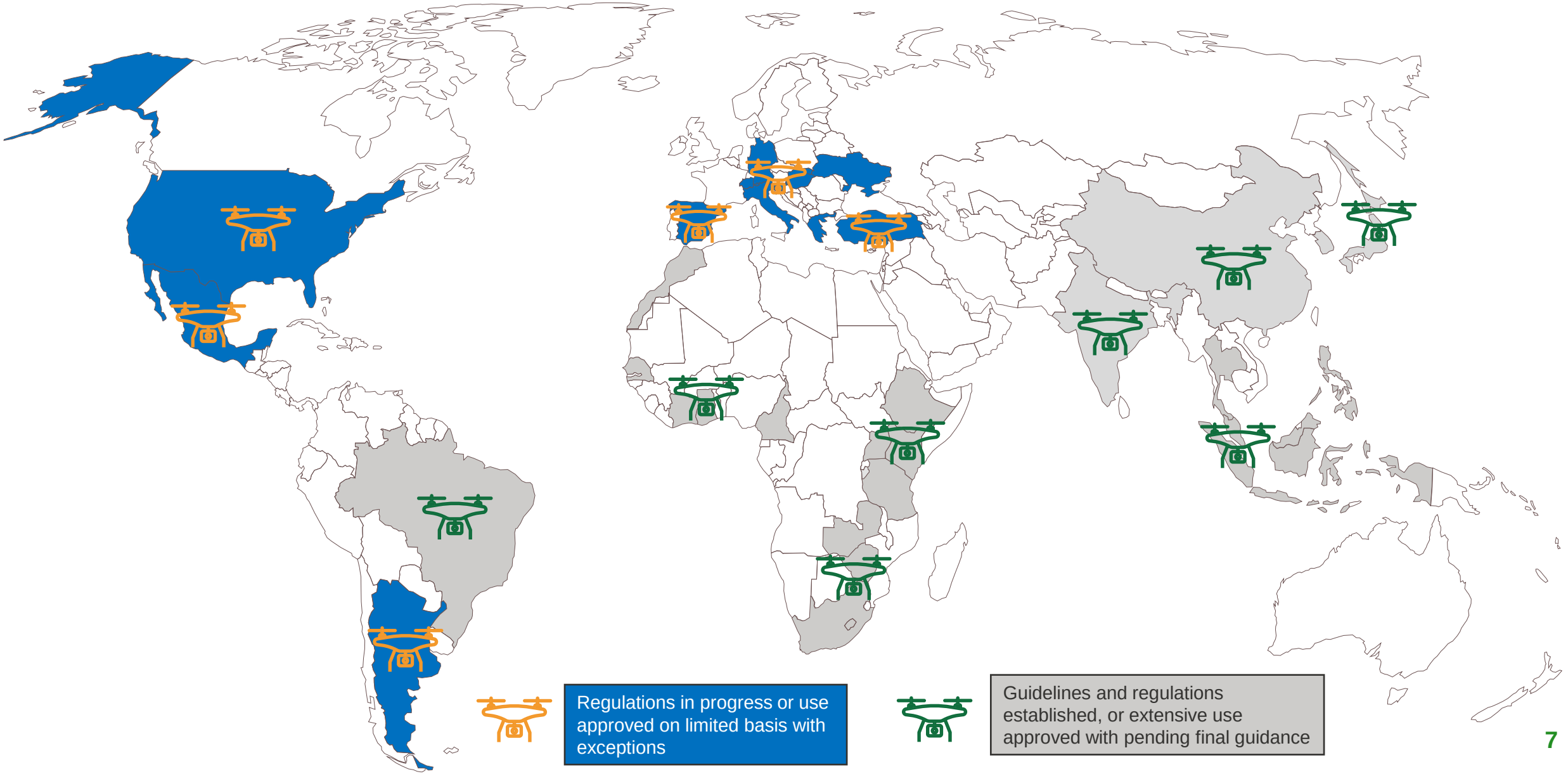
2. UAV airplane Sprays Near Power Lines

UAV Applications Outside Asia - Switzerland

Switzerland among few EU countries that have aerial application approved, use of helicopters for spraying in difficult to reach vineyards grown in steep hills.

Transition from there to UASS by conducting their own studies to show the uniformity of spray with UASS in vineyard, guideline ISO 16122-2 issued

Countries In Process or with Regulatory Approvals for use of UAV/UASS for Pesticide Applications



OECD WPP Drone/UASS Subgroup - Previous Presentation

- **The Subgroup has become an advisory body to provide expert input on how to fill knowledge gaps**
  - Grouping of 'state of knowledge' recommendations needed to develop / implement
  - Workstreams Established, work in-progress

Work Package #1 – off-site exposure including exposure modeling (BIAC / CDN / US)

Work Package #2 – scanning / survey to stakeholders (UK)

Work Package #3 – 'best practices' guidance (BIAC)

Work Package #5 – connect to ISO (Research Institute / ISO representative)

Grouping of Recommendations from 'State of Knowledge' Report
#7. Develop an empirical database and standard drift curve or model to estimate off target exposure. #9. Develop a useable publicly available model for predicting spray deposition and drift including parameters for static hovering, forward speed and spray equipment.
#1. Establish database to classify UASS into groups to reduce burden of testing each different platform/configuration. #2. Survey manufacturers about future trend of UASS design/ use profiles to produce a benchmark platform as a common starting point for regulators (others may differ and need bespoke assessment but would cover most common uses). #8. A data gathering exercise for operational practices mixing, loading, cleaning and transport scenarios.
#5. Develop and publish a user-friendly summary of best practice (including the essential nature of calibration), pitfalls and a trouble shooting guide (both for generating trials data and applying pesticides in practice), including preliminary recommendations for operational parameters (release height, application volumes, forward speed and spray quality). #6. Promote the advice in Annex D recommendations for researchers conducting UASS drift studies.
#4. Develop set of standard methodologies that will support regulatory decision making.
#3. Encourage manufacturers to develop improved spray systems including the pump systems, nozzle placement and closed transfer loading systems. * ISO standard project

Work Package 3 Update (Best Practices)

Recommendation 5 & 6

- Develop and publish a user-friendly summary of best practice (including essential nature of calibration), pitfalls and trouble shooting guide (both for generating trials data and applying pesticides in practice), including preliminary recommendations for operational parameters (release height, application volumes, forward speed and spray quality).
- Promote advice for researchers conducting UASS drift studies

Work Package 3 – OECD & UAPASTF

- Best Practices for Safe and Effective Application of Agrochemicals Using Unmanned Aerial Spray Systems (UASS)
- Audience: farmers, service providers, manufacturers and extension and research personnel
- Global level guidance on the key parameters that impact spray deposition while reducing off target movement (drift) using Unmanned Aerial Spray Systems (UASS)

UAPASTF Best Practices Document Process

- UAPASTF BMP technical committee formed March 2022
- Reviewed related available Stewardship, SOP and BP documents for UAV and manned aircraft: Crop Life (CLI, CLA); Int. Org. (FAO), Governments (India, Japan); Associations (NASDARF); Pesticide industry (FMC, Valent Biosciences); Drone spraying servicer (Rantizo)
- Delivered first draft November 2022 and sent for review by multiple internal and external experts (NDA signed with TF)
- Comments incorporated, “Final Draft” sent broadly to additional international experts and organizations for review – March 2023
- Today’s BMP workshop to get input from OECD workshop attendants

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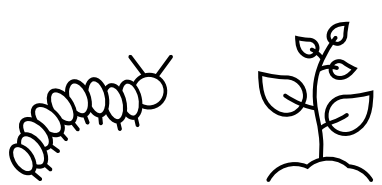
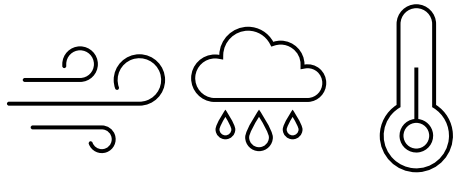
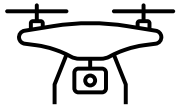
Unmanned Aerial Spray System (UASS) Best Practices Components

Best Practices for Safe and Effective Application of Agrochemicals Using Unmanned Aerial Spray Systems (UASS)







PEST AND CROP

- Assess if use of UASS is the appropriate method for the crop/pest targeted; use labeled
- Pest/disease/weed ID, threshold, timing
- Water volume/Spray coverage adequate for crop stage, pest location

PRODUCT AND TANK MIX

- Product: attributes i,e., systemic Vs contact, use rate, rainfastness
- Clean tank, lines, and booms
- Tank mix: water quality and temp, adjuvants, buffers, compatibility, order of addition, suspensibility etc.
- Label requirements

ENVIRONMENTAL CONDITIONS

- Preferred conditions: wind, temperature, relative humidity
- Marginal conditions: low or high winds, Surface temperature inversions (thermal inversion), rain
- Label requirements to avoid operator exposure and sensitive areas: water bodies, pollinators etc.

OPERATOR/CERTIFICATION AND EQUIPMENT/SPRAY SYSTEM

- Certifications to Apply Pesticides with UAVs
- Select equipment UAV, nozzle type, flow rate capacity for required water volume
- Calibration and deposition
- Preapplication crew briefing, field survey, flight path
- Monitor spray quality

Considerations to Deliver Product to the Target Using UAV

Oil Palm - Bagworms

Almond- Navel Orange Worm
Spray must reach the almond hull split suture

Rice Stem Borer

Brown Plant Hopper

Fall Armyworm

The High Number of Drone/UASS Platforms Makes it Difficult to Make Broad Recommendations

Single Rotor- Gasoline/Battery

Single Rotor – Battery

Multi (4) Rotor
& in-line CDA nozzle

Fixed Wing – Battery/No Rotors

Multi (8) Rotor
& in-line hydraulic nozzle

Multi (6) Rotor – Boom config.

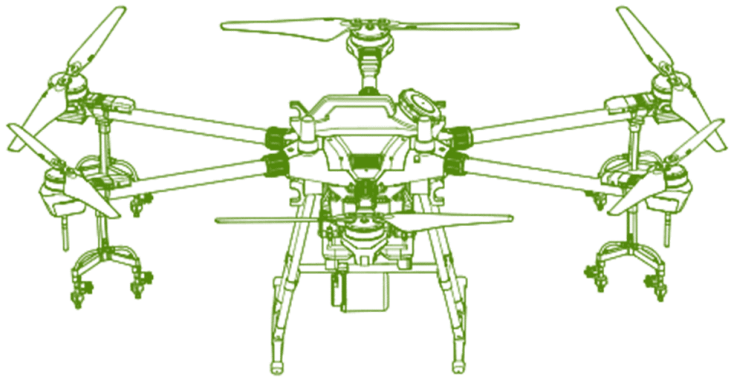
Drone Technology for Pesticide Application:

Aircraft vs Spray System

UAV system and flight control

Motors & Propulsion System

- Propeller
- Motors
- Electronic Speed Controller



Power, Sensing, Control System

- Navigation Sensor
- Battery
- Flight Controller

Liquid Delivery System

Spray tank	• Small payload capacity (10-40 L) • **No tank agitation/ bypass**
Delivery pump	• Diaphragm or peristaltic pumps • Limited by mass flow rate, low capacity**, impacts volume output/droplet size**
Nozzle & boom	• Various configurations, booms or under rotor • Some UASS not flexible on type of nozzle that can be used

Spray Equipment Calibration Is Critical – Not well Understood for UASS

Calibration ensures:

- Delivery of accurate amount of product as label rate
- Uniform distribution of active ingredients over the field or to the targets
- Three major factors influence sprayer calibration:
  - Ground speed, i.e., flight speed (km/h, miles/h)
  - Swath width (meters or feet) – Impacted by flight height, nozzle/boom configuration
  - Flow rate (L/min or g/min)

Best Practices Guidance Document Next Steps

- Draft shared with UAPASTF collaborators for review, including members present at this workshop
- Expert feedback, Day 2 of CRD-HSE and OECD CRP sponsored workshop on the application of pesticides by drone, May 23-24, 2023, York, UK
- Incorporate workshop feedback and finalize BMP document
- Decide who/how document will be updated

THANK YOU!