ADJUSTABLE AGRICULTURAL SPRAYS IN CROSS WIND

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Spraying of insecticides and pesticides for augmenting agricultural production has been in place for decades. It is common practise to mount sprayers on a boom attached to a tractor. Apart from posing a health hazard, this arrangement of spraying can often be a wasteful exercise particularly in strong cross winds. This is because of a common menace of spray drift (the drifting away of the spray from the intended target foliage due to the action of strong winds). Studies have indicated that the commonly used hollow cone spray nozzles provide a droplet spectrum with diameters ranging from 50 to 400 μm. Droplet sizes of diameter below 150 μm are most susceptible to spray drift, thus leading to a loss of approximately 30% (by volume) on spraying. In this project, we propose to quantify, and thence ameliorate spray drift by fabricating an adjustable spraying system. In our analysis, we focus on the interaction between an external cross flow and the spray jet. This is to understand the mechanistic details of the behaviour of droplets in turbulent air flows. We illustrate the use of a mechanical device attached to a tractor-mounted spray-boom arrangement enabling a farmer (a non-expert in fluid mechanics) to easily sense the speed and direction of the ambient cross wind (see figure 1). A simple manual switch operation corresponding to strong, moderate and weak cross winds can then be activated to realign the nozzles, thus countering the dissipative action of the cross wind. The nozzles are fixed onto parallel links, connected through a four-bar mechanism actuated by the rotation of a low rpm DC Motor, with a torque of 396 N-m, high enough to enable rotation on an array of 20 nozzles. The gadget is provided with preset values of angles to be turned for different ranges of cross wind speeds.

Analytical models have been developed for all the practical ranges of the ratio of the induced air jet speed to the cross wind speed. Such a model provides a quantified relation between the strength of the cross wind and the angle by which the nozzle should be turned so as to counter the drift and increase efficiency of spraying. A suite of tailor made analytical models coded by us, lend them to help visualise size segregated movement of spray droplets in cross winds. The modelling exercise was necessary not only to plan experiments (to determine optimal spray release height vis-à-vis the strength of the cross wind), but to also help validate and quantify modelled spray drift with observations. To our knowledge, such a definitive study has not been done before. This project clearly falls within the ambit of mechanical engineering research focused towards rural development through modest means.