



Figure S1. Torque transducer calibration.

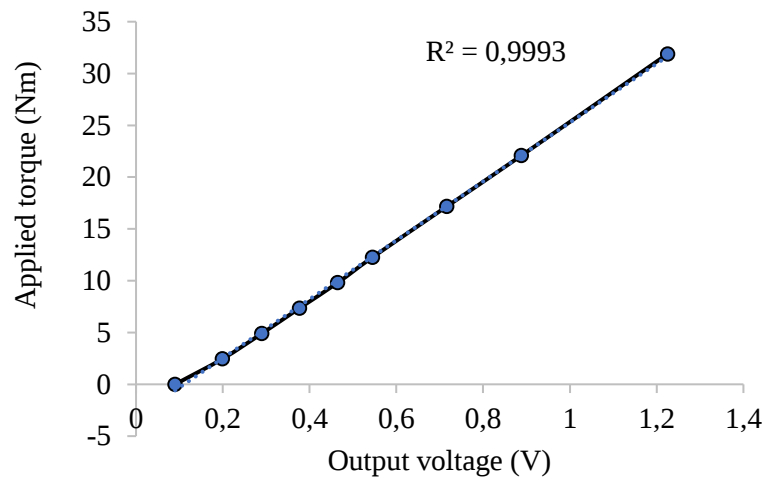


Figure S2. Calibration curve.



Figure S3. Laboratory experiment for measuring cutting and pushing torque.

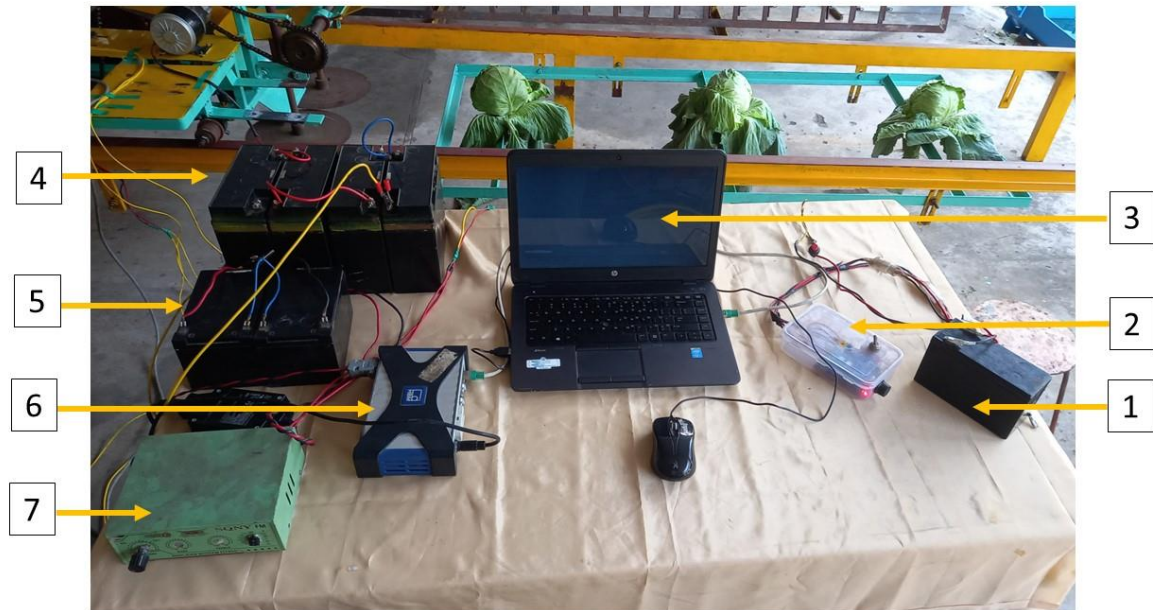


Figure S4. Data acquisition system (DAS) and power supply in the experiment. 1, battery for pusher; 2, direct current (DC) motor controller for pushing; 3, laptop; 4, batteries for cutting; 5, batteries for propelling and conveying; 6, data acquisition system (HBM); 7, DC motor controller for propelling and conveying.