As earth's population and the demand for food grows the need for robotic agricultural rovers that can provide around the clock labor and accurate high speed non-invasive crop health monitoring capabilities becomes paramount. One example drawing considerable attention is the staggering losses the agricultural industry is taking due to plant pathogens, which could be controlled with an autonomous rover equipped with spectroscopic crop health monitoring equipment. To realize the final goal of an autonomous field rover capable of navigating through agricultural fields first precise navigational and control units must be designed. While there are many things a control engineer can do in the design of such systems it is desirable for the engineer to base the navigational and control unit design on an easy to use physics, or plant, model. Many plant models have been suggested for wheeled mobile robots in the past however, the majority of them are based on wheel odometry which is not suitable for field rovers working in soft terrain where large amounts of wheel slip are present. In this thesis an approximate control affine model for an autonomous field rover working in soft terrain is presented. First terramechanic wheel terrain interaction models are used to analyze the underlying physics that guide the motion of an individual wheel working in deformable terrain. Using the terramechanic models and curve fitting techniques, approximate wheel terrain interaction models which render the full agricultural rover model in control affine form are found and the control affine form is presented. The hybrid extended Kalman filter algorithm is utilized to estimate the approximate model parameters and robot velocities in real time.