Wind energy is on an upswing due to climate concerns and increasing energy demands on conventional sources. In wind farms, wind turbines affect each other depending on their position and operation modes. Therefore it becomes essential to optimize the wind farm power production as a whole than to focus on individual wind turbines. The work presented here develops a hierarchical power optimization algorithm for wind farms. The upper level scheme formulates and solves a quadratic constrained programming problem to allocate power to wind turbines in the farm while considering the aerodynamic effect of the wake interaction among the turbines. Whereas the lower level optimization algorithm is based on a leader-follower structure inspired by the local pursuit strategy. A nonlinear wind turbine dynamics model is adopted for the low level study with loading and other constraints considered in the optimization. The stability of the algorithm in the low level is analyzed. Simulations are used to show the advantages of the method such as the ability to handle non-square input matrix, non-homogenous dynamics, and the scalability in computational cost.