The most important factors to examine the optimal condition of heat pump fruit dryer (HPD) and to minimize HPD cost are recycle air ratio (RC), evaporator bypass air ratio (BP), airflow rate (m_a), and drying air temperature (T_{di}). Mathematical models of papaya and mango glace' drying using HPD are developed and validated with the experimental results. The optimal criterion is minimum annual total cost per evaporating-water. From a simulation results, the optimal operating conditions of papaya glace' drying are as follows: recycle air ratio of 100%, evaporator bypass air ratio of 69%, airflow rate of 20.72 kg/h-kg of dry product, and drying air temperature of 55 °C. The best conditions of mango glace' drying are recycle air ratio of 100%, evaporator bypass air ratio of 71%, airflow rate of 30.88 kg/h-kg of dry product, and drying air temperature of 55 °C. For sensitivity analysis, the annual total cost per evaporating-water of HPD is linearly proportional to both interest rate and electricity price, as well as decreased with increasing life-time.