In 2013 the World Health Organization recommended the initiation of antiretroviral therapy (ART) to any person who tests HIV positive irrespective of his/her CD4+ count. However, implementation of the new guidelines poses a lot of challenges especially in Sub-Sahara Africa such as: drug side effects, drug resistance-mutations and significant financial burdens. Most importantly, it has been established that HIV resistance and subsequent virologic failure occur in a substantial proportion of HIV-infected patients receiving HAART. This study therefore, seeks to investigate the emergence of drug resistant HIV virus during treatment with the aim of determining the proper use of HIV therapy that would lessen drug resistance. To carry out the analysis a ten dimensional in-vivo mathematical model is proposed for HIV dynamics. The model is formulated in such a way that it takes into account two virus strain, that is, the wild type as well as the naive type HIV virus. The in-vivo model is shown to be both biologically meaningful and mathematically well posed. The existence of unique infection-free equilibrium point is determined and both its local and global stability investigated. In addition, the basic reproduction number for each viral strain [pink]is computed using the next generation matrix method. An optimal control model is proposed and analysed by applying Pontryagin maximum principle, to obtain the optimal drug combination for HIV treatment. Here two drugs, that is, Reverse Transcriptase inhibitor and Protease inhibitor are used as the controls in the model. We provide an objective function for the minimization of the number of wild type HIV virus and the drug resistant virus as well as the costs associated with the use of Reverse Transcriptase inhibitor and protease inhibitor. The forward backward sweep method is applied to numerically solve the optimality system. From the numerical simulations, it is evident that protease inhibitor is the most effective drug in controlling HIV infection. The results suggest that prolonged use of HAART leads to development of drug resistant and that people with drug-resistant infection could play a core role in the epidemic of HIV.