We theoretically investigated the elastic deformation and piezoelectric field in InAs quantum dots grown on (N11) GaAs substrates. Particular attention was given to the influence of the substrate orientation on both the volume deformation of the dot and the strain-induced piezoelectric field. The piezoelectric effects are enhanced by the lower symmetry growth directions. The influence of the piezoelectric fields on the electron and hole ground states for a (N11) quantum dot was also investigated within the effective mass approximation. We find a significant dependence of the fundamental transition energy on the polarity of the substrate's surface.