Instant noodles are currently the most important wheat-based convenience food preferred by consumers globally. The present study was devised to explore the influence of formula ingredients and processing parameters on the instant noodle quality and to investigate the suitability of Indian wheat varieties for instant noodle production. Response surface methodology (RSM) was applied to optimize the formulation and processing conditions for preparation of instant noodles taking into account five response variables i.e. oil uptake, cooked weight, cooking loss, hardness and overall acceptability. Optimal levels of formula ingredients including water (30.97%), alkaline salt (0.23%), guar gum (0.28%) and salt (1.54%) and processing conditions comprising of mixing time (4.0 min), dough sheet thickness (1.2 mm), steaming time (6.4 min), frying temperature (142°C) and frying time (2.0 min) were obtained. Instant noodles were prepared from fifteen diverse wheat varieties varying widely in their grain and flour quality. Dough rheological parameters obtained by Mixolab and flour analytical properties were correlated with the quality of instant noodles. The Mixolab parameters including dough development time (DDT) and dough stability (DS) had a marked positive effect on quality of instant noodles. Flour samples with lesser values of protein content, SDS sedimentation volume, thermal stability of proteins, dough stability and dough development time were found to be linked with inferior noodle quality. Oil uptake and cooking time of instant noodles was found to be highly associated with protein content of flour, gluten quality and strength. The results indicated that noodle springiness was more related to R/E ratio, gluten index and glutenin content of flour samples. Amylose content was positively associated with noodle cooking time, textural properties, and overall acceptability, while reduced the oil uptake and cooking loss in noodles. Starch pasting and gel properties significantly affected the noodle quality. It was found that higher starch solubility led to an increase in cooking loss and alone explained for the 85% variability in cooking loss in noodles. Starch paste final viscosity and setback viscosity showed a positive association with noodle cohesiveness/elasticity. Setback, C3, gel gumminess and paste viscosity effectively (R²= 0.928) determined the noodle cohesiveness, while noodle chewiness was dependent mainly on amylose content, pasting temperature and gel springiness. Medium strong flours performed better in noodle making, while weaker flours demonstrated poor noodle quality. The weaker flours from varieties HW 2004 and C 306 having High molecular weight glutenin subunit composition (HMWGS) of Null, 2+12 and 20 alleles expressed at Glu-A1, B1 and D1, respectively could not withstand sheeting and resulted in high breakage during processing, rough noodle surface, higher oil uptake and inferior noodle quality. Wheat varieties DBW 16 and WH 542 were identified as best noodle making varieties, while WH 1021 and HW 2004 were identified as poorest noodle making varieties. The good and poor noodle making varieties varied significantly in Mixolab properties of dough, DSC profile, amylose content, starch solubility, swelling power and SEM (Scanning Electron Microscope) of starch granules and noodle. RAPD (Random Amplified Polymorphic DNA) primers were also used to assess the genetic diversity of wheat varieties which were found effective in segregating the good and poor noodle making wheat varieties.