groups	nhaz	HII	explanation	refs	comment
none	0	0			includes I, W and IW
D	1	3	• FAO reported an average of 19 percent reduction in yield globally • SCIP (2023) reported an average yield reduction of 47% for wheat	FAO2023; SCIP2023	19% yield loss
F	1	2	floods affect the physical structure of soils and nutrient cycling, resulting in potentially irreversible damage to agricultural productivity and ecosystem functioning flood risk and impact on crops have shown marked temporal and spatial variabuluty due to weather and topographic condions: precpitation, evaporation, topography, vegetation, soil, river flow, and flood control infrastructure FAO reported an average of 16 percent reduction in yield globally	Furtak2023; FAO2023	16% yield loss
FI	1	1	Some case can observe that flooding can destroy irrigation, but it more than often serves as drainage for flood water	Das2025	
FIW	1	2	High soil moisture prevents the soil from absorbing flood water, which may worsen the impact of Flooding to crops	Extrapolation from literatures	
FW	1	3	High antecedent moisture saturates soils and reduces storage, increasing runoff and waterlogging severity for the same rain input	Penna2011; Moragoda2022; Tiefenbacher2021; Massari2023	
S	1	2	20% of total cultivated and 33% of irrigated agricultural lands are afflicted by high salinity. 50% of arable land would be salt affected in 2050	Shrivastava2014	35% yield loss (limited to major crops)
SI	1	1	Literature states that improper irrigation, where drainage is not established, results in salts proliferating along the rootzone. Coastal farm areas below sea level experience greater loss, as the seawater infiltrates the irrigation. Areas with arid climate conditions experience much worse However, according to expert consultation, irrigation can mitigate the effects of salinity	Shirvastava2014; Shirvastava2014	
SW	1	3	Shallow saline water tables maintain high soil moisture with high salt concentration near roots, increasing ion toxicity	Barrett-Lennard2003	
DI	1	1	Supplemental water restores transpiration and evaporative cooling, strongly buffering drought impact and stabilizing yield	Luan2021	
DIW	1	1	Introducing soil-water to the interaction between drought and irrigation facilitates the supply of water to crops.	Extrapolation from literatures	
DW	1	2	• In a study conducted by Bakar (2025), forested areas demonstrated higher resilience from flash droughts, while rainfed crop areas exhibited rapid moisture loss and consequently resulted in slower recovery • Soil water holding capacity is only relevant to rainfed crops (Urfels) • Higher antecedent/root-zone moisture buffers water stress, sustaining stomatal function and reducing drought damage (Heino2023)	Bakar2025; Expert opinion (Urfels, Anton); Heindo2023	
R	1	3	Holleman reported an average of 1 percent reduction in yield globally • Steady supply of water smooths spikes in variability (Schmidt, 2024)	Holleman2020	13% yield loss
RI	1	1	• Supplemental irrigation enables farmers to grow long-maturing maize varieties can be sown during short rainy season (Muluneh2016)	Schmidt2024; Muluneh2016	
RIW	1	1	Effects of changed rainfall can be offset by irrigation alone. With sufficient soil moisture, effects of the hazard may be negligible	Extrapolation from literatures	
RW	1	2	• High antecedent moisture predisposes saturation-excess runoff during heavy rains, amplifying field flooding/erosion impacts (Penna2011) • Periods of shortened and erratic rainy seasons can impair vital ecosystem services such as soil moisture retention (Enyew2025)	Penna2011; Enyew2025	

T	1	3	• FAO reported an average of 26 percent reduction in yield globally • SCIP (2023) reported an average yield reduction of 60% for wheat	FAO2023; SCIP2023	26% yield loss
TW	1	3	• An increase in soil moisture, the change in soil surface temperature caused by a 1% change in soil moisture decrease (Zhang, 2022) • During cases of extreme, high transpiration rate can excerbate plant water stress by dehydrating the leaves and depleting soil moisture, but also mitigate heat stress (Albasha2024)	Zhang2022; Albasha2024	
SIW	1	1	If there is no proper drainage or path to expel salts along the rootzone, salts may accumulate in the rootzone	Extrapolation from literatures	
TI	1	1	• Irrigation partially offsets the negative impact of heat stress (Birthal2021) •Irrigation increases evapotranspiration and canopy cooling, reducing hottest-day temperatures and mitigating heat injury (Thiery 2017; Birthal 2021) •Irrigation substantially cools hottest-day temperatures over irrigated land (Thiery2017) • Irrigation can mitigate a a large part of the heat penalty on yield (Urfels) • Irrigation increases lantent heat flux and canopy cooling, strongly mitigating heat stress impacts on crops (Lehmann2020)	Birthal2021; Expert opnion (Urfels, Anton); Lehmann2020	
TIW	1	1	Based on the "TI" interaction effection, irrigation offsets the negative impact of heat stress, which is carried over with with an increase in soil moisture	Extrapolation from literatures	
DF	2	2	Antecedent drought can create storage deficits that slightly delay saturation during initial rains, modestly dampening early flood impacts; effects are context-dependent and can reverse with hydrophobic soils (Luk1985)	Luk1985	
DS	2	4	• considered as the biggest agricultural disaster, considered to have greatest negative impact on food security • results to a greater reduction in root growth than experiencing salinity alone	Furtak2023	
FS	2	3	•Dampening or no interaction if the crop has a resource-conservative tolerance strategy; otherwise amplifying (Wei) • Waterlogging can diminish the adaptation strategies that plants use to cope with salinity, such as the exclusion of Na+ and CL-, inhibiting root respiration, and increasing uptake of Na+ (Sanchez-Bermudez2022) • On the contrary, Colmer (2008) observed that waterlogging plus salinity synergistically impair ion homeostasis and root respiration, worsening plant damage vs. either stress alone. • Hypoxia under waterlogging disrupts ion homeostasis and root respiration, increasing Na+/Cl− injury; most crops show supra-additive damage under combined salinity and flooding (Barrett-Lennard 2003; Colmer & Flowers 2008) • Coastal and tidal flooding drive saline intrusion and groundwater rise; osmotic stress plus hypoxia severely harm crops (Su2025). Su (2025) also added that soil salinity effects after flooding were recorded to last from 2 months to 2 years for some records. The impact of storm surges is expected to increase by 20% (Su2025). • Bi-weekly flooding events increases root zone salinity from 0.3 dSm- to over 6.0 0.3 dSm- (Su2025) • SCIP (2023) reported an average yield reduction of 40%	positive: Expert opinion (Wei, Xiaojing) negative: Sanchez-Bermudez2022; Colmer 2008 ; Su2025; SCIP2023	
FSI	2	3	A proper irrigation system can reduce the impact of flooding and salinity. Areas, however maybe experiencing coastal flooding, which is much more destructive	Expert consultation	
FSW	2	4	Saline soil stunts root development, which may worsen the impact of flooding to crops	Extrapolation from literatures	

DFI	2	2	Irrigation cancels the effect of both drought and flooding. Also, the antecedent drought (based on the DF entry) is not felt by the crop as it is already irrigated	Extrapolation from literatures
DFIW	2	3	Irrigation cancels the effect of both drought and flooding. Also, the antecedent drought (based on the DF entry) is not felt by the crop as it is already irrigated. With soil moisture readily available to crops. Impact of drought may be negligible	Extrapolation from literatures
DR	2	4	• Changed rainfall and drought at different stages affect germination, weed infestation and insect disease incidence (Shah2021) • Erratic rainfall disrupts moisture cycles (Seviratne2021) • Water deficit reduces evaporative cooling while heat accelerates photoinhibition; co-occurrence yields supra-additive stress (Zandalinas2018) • Observed increases in short-duration rainfall extremes are consistent with intensification under warming (Fowler2021) •Asada (2009) conducted a study on the effects of rainfall variation. Results showed that rainfall change is favorable for some regions, as stable rainfall can decrease the drought effect and help stabilize rice production variation. However, there are also cases reported in the same study where the amount of rainfall was not enough, which resulted in a yield loss. •Erratic rainfall increases dry-spell length and timing mismatches, amplifying agricultural drought intensity in rainfed systems (Bal2022)	Negative: Shah2021; Seviratne2021; Pascual2022; Zandalinas2018;Fowler2021; Bal2022 Positive: Asada2009
DRW	2	3	High soil moisture reduces the effect of drought and changed rainfall, however, the impact of the two hazard is not fully resolved resolved	Extrapolation from literatures
DSW	2	4	Net effect of drought and salinity prevails	Extrapolation from literatures
FR	2	3	• Heavier bursts height flood risk (Seviratne2021) •Trend toward short, intense events raises runoff efficiency and flood peaks, increasing crop inundation risk (IPCC AR6 Ch.11; Westra 2014) • More intense rainfall increases rainfall erosivity and ponding, heightening waterlogging and submergence risks that depress yields (Panagos2017)	Seviratne2021; Panagos2017
RS	2	3	• Erratic rain hinders effective salt leaching. (Eswar, 2021) • Insufficient leaching and poor drainage drive secondary salinization in dryland (Qadir2014)	Eswar2021
DFW	2	2	Drought and flooding slightly slightly cancels their effects, while soil moisture ensures a supply of water during drought	Extrapolation from literatures
DT	2	4	• reduces harvest index, shorten plant life cycle, and alter the number, size, and composition of seeds • Changes in physiological and metabolic processes were also observed • SCIP (2023) reported an average yield reduction of 72% for wheat	Furtak2023; Sanchez-Bermudes2022; SCIP2023
FRW	2	3	Soil moisture and flooding slightly offset the effect of changed rainfall. Flood water cannot be fully absorbed by the soil due to high soil moisture	Extrapolation from literatures
FT	2	3	• Zhen (2020) highlighted the physiological changes observed in rice plants upon exposure to both high temperature and waterlogging. This, however, failed to cause significant damage to rice crops • High temperatures increase respirator demand and oxygen depletion under waterlogging, worsening crop damage versus flooding alone (Schillerberg2024)	Zhen2020; Schillerberg2024
FTW	2	4	Interaction between F and W may not be favorable, as flood water will not be absorbed. Along with extreme heat, plant may experience further stress	Extrapolation from literatures
DRI	2	1	Irragation offsets the effects of drought and changed rainfall	Extrapolation from literatures

DSI	2	2	Irrgation offsets the effects of drought and salinity, but salts may settle along the rootzone	Extrapolation from literatures
FRI	2	1	Irrigation can offset the effects of flooding and changed rainfall	Extrapolation from literatures
FSIW	2	3	Irrigation may offset the effects of flooding and salinity, however, with high soil moisture, draining flood water may take longer than usual. Further, since the area is observed to experience salinity along with flooding, the area can be experiencing coastal flooding, which flood water contain higher levels of salinity	Extrapolation from literatures
RSI	2	1	Irrigation can offset the effects of changed rainfall and salinity	Extrapolation from literatures
DRIW	2	1	Irrigation can offset the effects of drought and changed rainfall regardless of high soil moisture	Extrapolation from literatures
DSIW	2	2	Irrigation can offset the effects of drought and salinity; however, with high soil moisture, salts may not be drained along the rootzone	Extrapolation from literatures
RSIW	2	2	Irrigation can offset the effects of changed rainfall and salinity; however, with high soil moisture, salts may not be drained along the rootzone	Extrapolation from literatures
DTI	2	2	Irrigation can offset the effects of drought and extreme heat; however, the combination may still entail a reduction in yield	Extrapolation from literatures
DTIW	2	2	Irrigation can offset the effects of drought and extreme heat; however, the combination may still entail a reduction in yield	Extrapolation from literatures
DTW	2	3	Soil moisture partially offsets the effect of drought and extreme heat	Extrapolation from literatures
FTI	2	2	Irrigation offsets the effects of flood and extreme heat	Extrapolation from literatures
FTIW	2	3	Irrigation offsets the effects of flood and extreme heat, however, given a high level of soil moisture, flood waters cannot be absorbed by the soil	Extrapolation from literatures
FRIW	2	3	Irrigation offsets the effect of	Extrapolation from literatures
RSW	2	4	Changed rainfall has a compounding effect on salinity	Extrapolation from literatures
RT	2	4	• Combined high temperature and soil water deficit were observed to be more detrimental (Seviratne2021) • High temperature and shifting precipitation patterns expands the incidence and range of sime insect pests that affect agricultural production (Walsh2020) • Changed rainfall was observed to increase temperature by 1 to 1.9 degrees celsius (Muluneh2016)	Seviratne2021; Walsh2020; Muluneh2016
RTI	2	1	Irrigation offsets the effect of changed rainfall and extreme heat	Extrapolation from literatures
ST	2	4	• High salinity results to severe reductions in root growth and water absorption (Machado2017; Sanchez-Bermudez2022) • Heat elevates evapotranspiration and ion toxicity under saline conditions, compounding osmotic stress (Munns2008) • SCIP (2023) reported and average yield reduction of around 80% for quinoa	Machado2017; Munns2008; Sanchez-Bermudez2022; SCIP2023
STI	2	2	Irrigation offsets the effect of high temperature but salinity can still profilerate to crops	Extrapolation from literatures
STW	2	4	Soil moisture can slightly offset the effect of salinity and extreme heat, but not as much as irrigation	Extrapolation from literatures
RTW	2	4	Soil moisture can slightly offset the effect of changed rainfall and extreme heat, but not as much as irrigation	Extrapolation from literatures
STIW	2	2	Irrigation can offset the effects of salinity and extreme heat	Extrapolation from literatures
RTIW	2	1		
DFR	3	5	Drought and changed rainfall without sufficient soil moisture result in a deficiency in water supply. Adding flooding to the mix would result to a drastic impact to a crop	Extrapolation from literatures
DFRI	3	3	Irrigation can offsets the effect of drought, flooding and changed rainfall	Extrapolation from literatures

DFS	3	5	Crops experiencing drought, flooding, and salinity without sufficient soil moisture can reduce the chance of a crop surviving	Extrapolation from literatures
DFSI	3	2	Irrigation can offset the effects of drought, flooding, and salinity	Extrapolation from literatures
DRS	3	5	Expericing drought, changed rainfall, and salinity reduces the chance of a crop surviving	Extrapolation from literatures
DRSI	3	3	Irrigation can offset the effects of drought, changed rainfall, and salinity	Extrapolation from literatures
FRSI	3	2	Irrigation can offset to certain extent the effects of flooding, changed rainfall, and salinity	Extrapolation from literatures
DFRIW	3	4	Irrigation can offset the effect of drought, flooding, and changed rainfall; however, given a soil moisture, flood water cannot fully be absorbed by the soil	Extrapolation from literatures
DFRW	3	5	Soil moisture cannot fully meet crop water requirements during drought and changing rainfall events.	Extrapolation from literatures
DFSIW	3	4	Irrigation can offset the effects of drought, flooding, and salinity to a certain extent; however, floodwater cannot be fully absorbed by the soil.	Extrapolation from literatures
DFSW	3	5	Soil moisture cannot fully meet crop water requirements during drought and salinity events	Extrapolation from literatures
FRS	3	5	Experiencing flood, changed rainfall, and salinity drastically reduces the chance of a crop surviving	Extrapolation from literatures
FRSIW	3	3	Irrgation offsets the effects of flood, changed rainfall, and salinity; however, with high soil moisture flood water cannot easily be absorbed by the soil	Extrapolation from literatures
DFT	3	5	Experiencing flooding, flood, extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
DFTI	3	3	Irrigation can offset the effects of drought, flooding, and extreme heat to some extent	Extrapolation from literatures
DFTIW	3	4	Irrigation can offset the effects of drought, flooding, and extreme heat to some extent; however, with high soil moisture flood water cannot easily be absorbed by the soil	Extrapolation from literatures
DFTW	3	5	Soil moisture cannot prevent the of the combination of drought, flooding, and extreme heat	Extrapolation from literatures
FST	3	5	Experiencing flooding, salinity, and extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
DST	3	5	Experiencing drought, salinity, and extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
DSTI	3	3	Irrigation can offset the effects of drought, salinity, and extreme heat to some certain extent	Extrapolation from literatures
FRTI	3	3	Irrigation can offset the effects of flood, changed rainfall, and extreme heat to some extent	Extrapolation from literatures
FSTI	3	3	Irrigation can offset the effects of flood, salinity, and extreme heat to some extent	Extrapolation from literatures
DRT	3	5	Without a steady supply of water, crops cannot survive the impact of the combination of drought, changed rainfall, and extreme heat	Extrapolation from literatures
DSTW	3	5	Soil moisture cannot prevent the impact of the combination of drought, salinity, and extreme heat	Extrapolation from literatures
FRT	3	5	Crops experiencing flooding, changed rainfall, and extreme heat without sufficient soil moisture can reduce the chance of a crop surviving	Extrapolation from literatures
RSTW	3	5	Soil moisture cannot prevent the impact of the combination of changed rainfall, salinity, and extreme heat	Extrapolation from literatures
FSTW	3	5	Soil moisture cannot prevent the impact of the combination of flood, salinity, and extreme heat	Extrapolation from literatures

FRTW	3	5	Soil moisture cannot prevent the impact of the combination of flood, changed rainfall, and extreme heat	Extrapolation from literatures
DSTIW	3	3	Irrigation can offset the impact of drought, salinity, and extreme heat to some extent	Extrapolation from literatures
FSTIW	3	3	Irrigation can offset the impact of flood, salinity, and extreme heat to some extent	Extrapolation from literatures
RSTI	3	3	Irrigation can offset the impact of changed rainfall, salinity, extreme heat to some extent	Extrapolation from literatures
FRSW	3	5	Soil moisture cannot prevent the impact of the combination of flood, changed rainfall, and salinity	Extrapolation from literatures
DRTI	3	4	Irrigation can offset the impact of drought, changed rainfall, extreme heat to some extent	Extrapolation from literatures
RST	3	5	Experiencing changed rainfall, salinity, and extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
FRTIW	3	3	Irrigation can offset the impact of flood, changed rainfall, and extreme heat to some extent	Extrapolation from literatures
DRSIW	3	3	Irrigation can offset the impact of drought, changed rainfall, and salinity to some extent	Extrapolation from literatures
DRSW	3	5	Soil moisture cannot prevent the impact of the combination of drought, changed rainfall, and salinity	Extrapolation from literatures
DRTIW	3	3	Irrigation can offset the impact of drought, changed rainfall, and extreme heat to some extent	Extrapolation from literatures
DRTW	3	5	Soil moisture cannot prevent the impact of the combination of drought, changed rainfall, and extreme heat	Extrapolation from literatures
DFRSI	4	4	Irrigation cannot fully offset the impact of four hazards	Extrapolation from literatures
DFSTI	4	4	Irrigation cannot fully offset the impact of four hazards	Extrapolation from literatures
DFST	4	5	Experiencing drought, flood, salinity, and extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
DFSTW	4	5	Soil moisture cannot prevent the impact of the combination of drought, flood, salinity, and extreme heat	Extrapolation from literatures
DFRTW	4	5	Soil moisture cannot prevent the impact of the combination of drought, flood, changed rainfall, and extreme heat	Extrapolation from literatures
DFRT	4	5	Experiencing drought, flood, changed rainfall, and extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
FRST	4	5	Experiencing flood, changed rainfall, salinity, and extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
DRST	4	5	Experiencing drouight, changed rainfall, salinity, and extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
DFRTIW	4	4	Irrigation cannot fully offset the impact of four hazards	Extrapolation from literatures
DFRS	4	5	Experiencing drought, flood, changed rainfall, and salinity dramatically reduces the chance of a crop surviving	Extrapolation from literatures
DFRSIW	4	4	Irrigation cannot fully offset the impact of four hazards	Extrapolation from literatures
DFRSW	4	5	Soil moisture cannot prevent the impact of the combination of drought, flood, changed rainfall, and salinity	Extrapolation from literatures
DFRTI	4	4	Irrigation cannot fully offset the impact of drought, flood, changed rainfall, and extreme heat	Extrapolation from literatures
DFSTIW	4	4	Irrigation cannot fully offset the impact of drought, flood, salinity, and extreme heat	Extrapolation from literatures
DRSTI	4	4	Irrigation cannot fully offset the impact of drought, changed rainfall, salinity, and extreme heat	Extrapolation from literatures

FRSTI	4	4	Irrigation cannot fully offset the impact of flood, changed rainfall, salinity, and extreme heat	Extrapolation from literatures
FRSTW	4	5	Soil moisture cannot prevent the impact of the combination of flood, changed rainfall, salinity, and extreme heat	Extrapolation from literatures
DFRST	5	5	Experiencing drought, flood, changed rainfall, salinity, and extreme heat dramatically reduces the chance of a crop surviving	Extrapolation from literatures
DFRSTI	5	4	Irrigation cannot fully offset the impact of drought, flood, changed rainfall, salinity, and extreme heat	Extrapolation from literatures
DFRSTW	5	5	Soil moisture cannot prevent the impact of the combination of drought, flood, changed rainfall, salinity, and extreme heat	Extrapolation from literatures
DRSTW	4	5	Soil moisture cannot prevent the impact of the combination of drought, changed rainfall, salinity, and extreme heat	Extrapolation from literatures
RSTIW	3	3	Irrigation cannot fully offset the impact of changed rainfall, salinity, and extreme heat	Extrapolation from literatures
DRSTIW	4	4	Irrigation cannot fully offset the impact of drought, changed rainfall, salinity, and extreme heat	Extrapolation from literatures
FRSTIW	4	4	Irrigation cannot fully offset the impact of flood, changed rainfall, salinity, and extreme heat	Extrapolation from literatures
DFRSTIW	5	4	Irrigation cannot fully offset the impact of drought, flood, changed rainfall, salinity, and extreme heat	Extrapolation from literatures