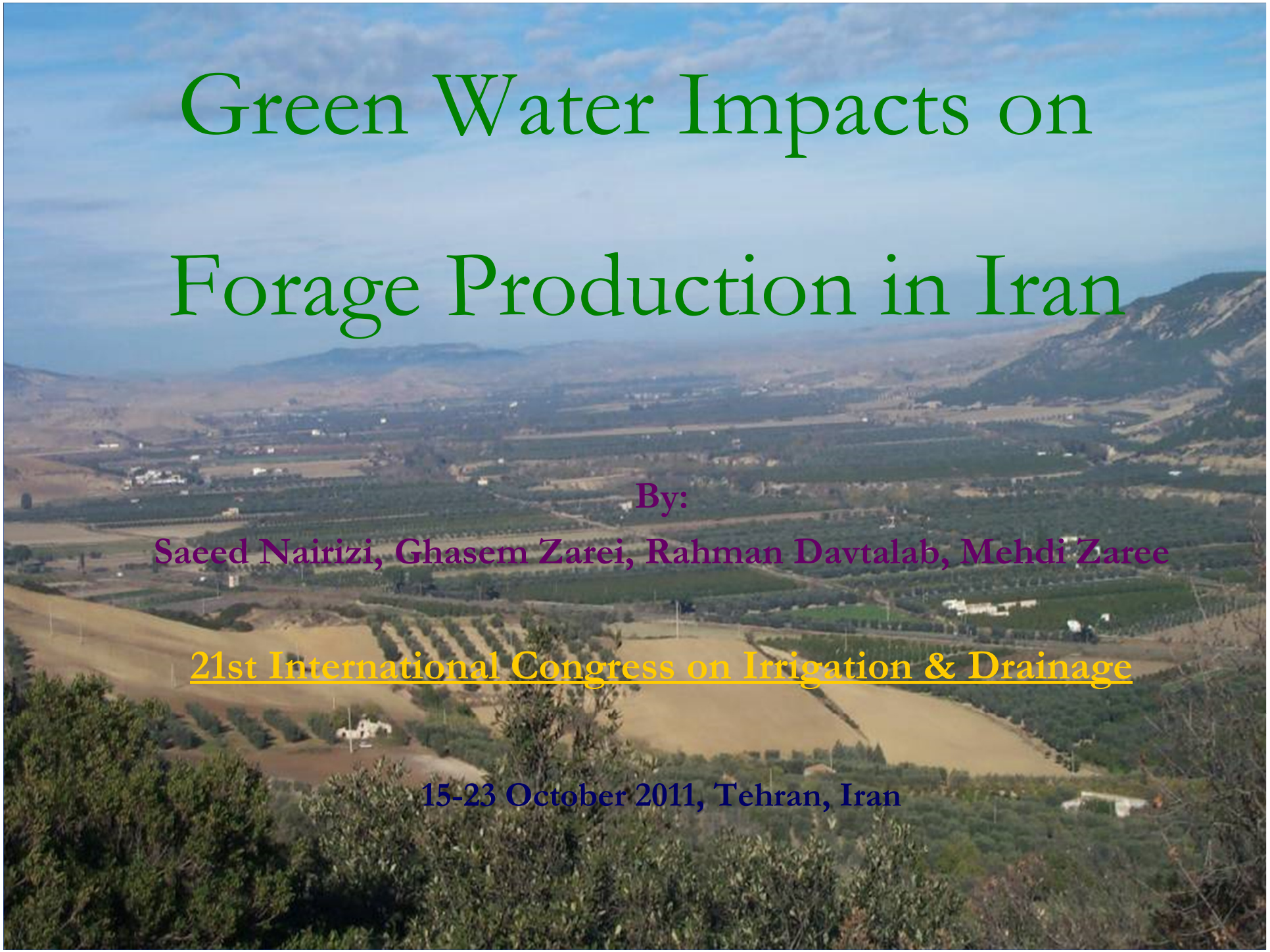

Green Water Impacts on Forage Production in Iran

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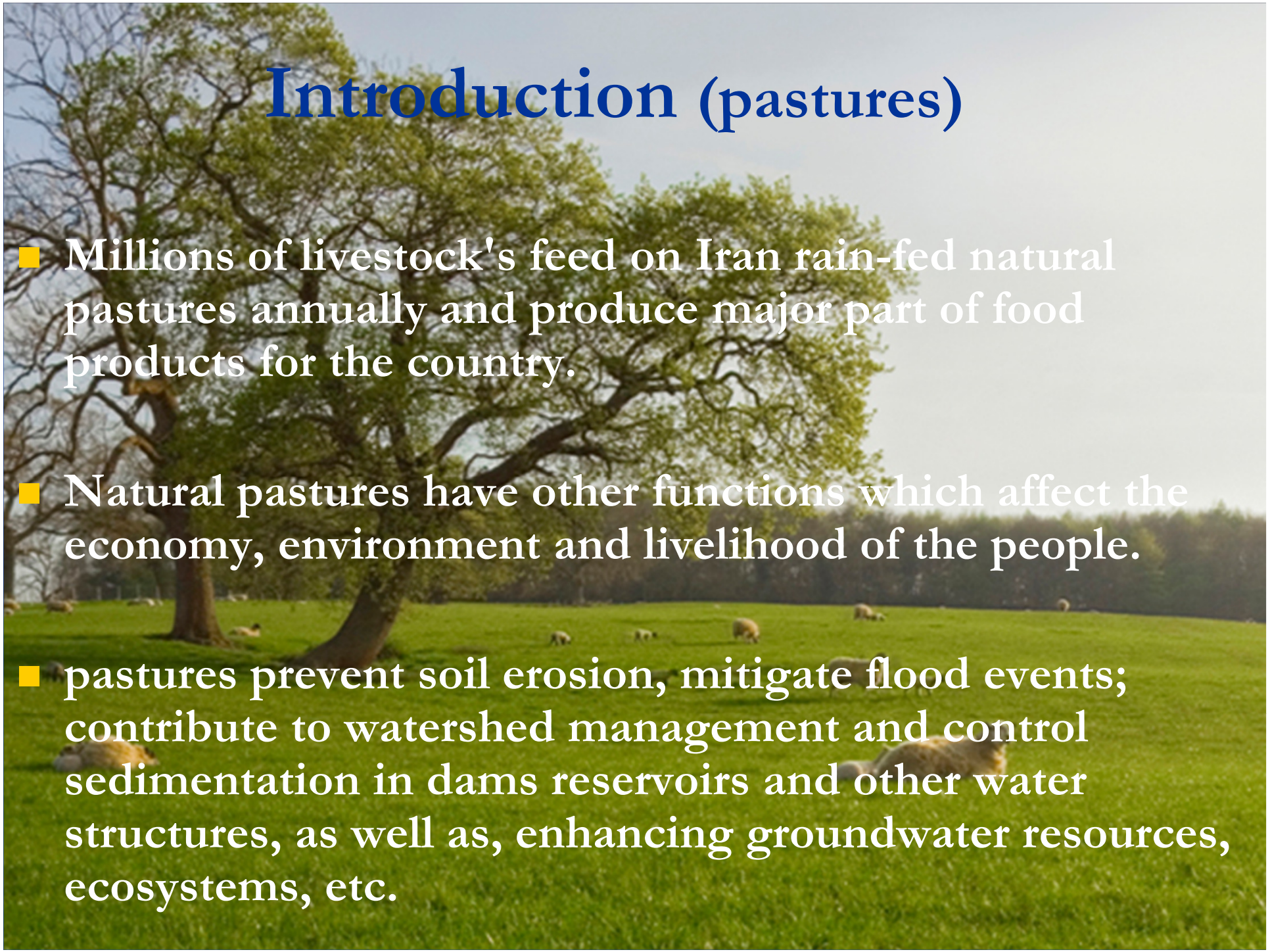
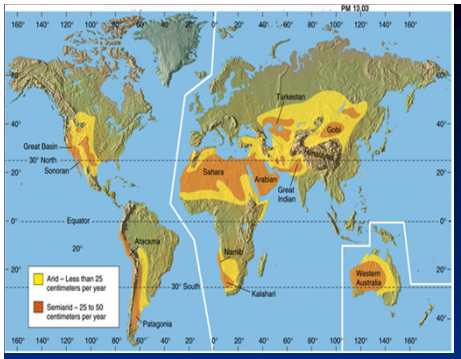


Introduction (pastures)

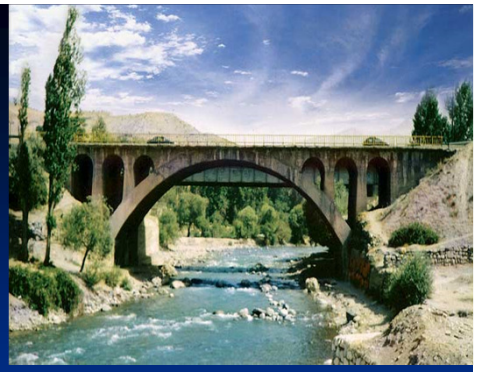
- Millions of livestock's feed on Iran rain-fed natural pastures annually and produce major part of food products for the country.
- Natural pastures have other functions which affect the economy, environment and livelihood of the people.
- pastures prevent soil erosion, mitigate flood events; contribute to watershed management and control sedimentation in dams reservoirs and other water structures, as well as, enhancing groundwater resources, ecosystems, etc.

Introduction (Land use)

- Iran has 164 million ha area.
- Iran pastures was estimated about 90 million hectares in 2005.
- About 55% area of Iran is covered by different kind of pastures (intensive, medium and poor).



Introduction
(Climate & Water Resources)



- Iran with 240 mm average annual precipitation and 2500 mm average potential evaporation per year is located in an arid and semi-arid region of the world.
- Iran precipitation volume is about 420 billion cubic meters annually.
- The average renewable (surface & ground) water in Iran is about 130 billion cubic meters per year.

Introduction

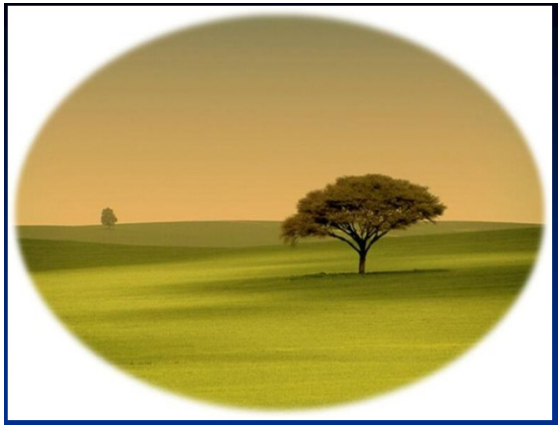
- By constructing many dams, water distribution and conveyance structures with several thousand billion dollars, the government has only achieved to control about 40 billion cubic meters of surface runoffs.
- About 20 billion cubic meters of such stored water is used for irrigated agriculture through modern and semi-modern irrigation water distribution network.
- Management of high volume precipitation on pastures, forests and rain-fed areas, which is estimated to be about 290 billion cubic meters annually, is an important task to be under taken.

Introduction

(Water Resources Component)

- **Blue water**: Part of precipitation which forms surface and groundwater
- **Green water**: Part of precipitation which infiltrates into the soil and consumed by existing vegetation directly as evapotranspiration
- **Grey water**: The volume of polluted groundwater or surface water resulted from human activities and agricultural practices disposed to the environment

Green water is considered as important water resources for the world agriculture which its potential value is unappreciated yet.



Introduction

- Researches on green water and blue water in Iran are limited.
- There are several studies on green, blue and grey water in the world.
- Mekonnen and Hoekstra (2010), classified and summarized the studies on various water resources components of the world.

Major studied on global water consumption and pollution by agriculture

Grey Water footprint	Green water footprint	Blue water footprint	Number of crops	Spatial resolution	Study
no	no	yes	-	continental	L; vovich et al. 1990
no	no	yes	-	continental	Shiklamanov 1993
no	yes	yes	-	Global	Postel et al. 1995
no	no	yes	-	Country	Seckler et al. 1998
no	yes	no	-	Global	Rockstrom et al. 1999, Rockstrom and Gordon 2001
no	no	yes	-	Country	Shiklomanov and Rodda 2003
no	yes	yes	38	Country	Hoekstra and Hung 2002
no	yes	yes	164	Country	Chapagain and Hoekstra 2004, Hoekstra and Chapagain 2007, 2008
no	yes	yes	11	30' x 30'	Rost et al. 2008
no	yes	yes	26	5' x 5'	Siebert and doll 2008, 2010
no	yes	yes	17	30' x 30'	Liu et al. 2009
no	yes	yes	22	30' x 30'	Liu and yang 2010
no	yes	yes	See text	30' x 30'	Hanasaki et al. 2010
yes	yes	yes	146	5' x 5'	Mekonnen and Hoekstra 2010

Methodology

- This research has been conducted by using the data corresponding to 2002 – 2004 water years.
- The status of various Iran pastures considering the area, grading and rate of harvestable forage production per hectare were determined (Iran Pastures and Forests Organization, IPFO).
- National land use map prepared by IFPO, from land-sat images in 2002- 2004, were used to analyzed the area covered by each category of pastures.

Methodology

- National isopluvial maps prepared by Iran Water Resources Management Company (IWRMC) taken from rainfall distribution Atlas at the Scale of 1-500000 were also used to identify the volume of precipitation on each category of land uses.

- Using the capabilities and provisions available in Arc GIS, the two maps were coalesced and determined the volume of precipitation on the pastures.

Methodology

- For calculation of economical value of water consumed by pastures, available data in IWRMC was used.
- Considering average cost of providing irrigation water through the construction of dam and related irrigation network, the cost of each cubic meter of water at the dam site, distribution canal system, and farm level for the index year of 2009 was calculated.
- Considering water use efficiency index of pastures, the economic value of water available to the consumption and production cycle of forage was obtained.

Conclusion and discussion
(Forage production in Iran pastures)

Kind of pastures	Area × 10^6 ha	Performance (Kg/ ha)	Present hay production and harvest (Million ton)		Potential production and harvest with PPM (Million ton)	
			Production	Harvestable	Production	Harvestable
Intensive pastures	14	290	4.6	2.3	24	12
Medium pastures	60	92	11	5.5	66	33
Poor pastures	16	16	1.5	0.8	9.4	4.7
Total	90	153	17.1	8.6	100	50

Conclusion and discussion

Forage production in Iran pastures

✓ Since very low yield in the poor pastures and other climatological, geological and soil restraints, activities for improving such pastures are very limited and they are excluded in this study.

✓ The area of intensive and average yielding pastures are about 74 million ha.

✓ The amount of hay production in the medium and intensive pastures of Iran is considerable. They produce about 15.6 million ton bio-mass per year with about 7.8 million average harvestable yields per year.

✓ With proper pasture management the potential bio-mass production and harvestable yield shall reach about 90 and 45 million tons per year , respectively.

✓ In case of employing proper pasture management and suitable operation in such pastures, the possibility of forage production increase shall be over 5 times as much as the present status.

Conclusion and discussion

Precipitation analysis on pastures of Iran

Kind of pastures	Area (Million ha)	Mean precipitation (mm)	Volume of precipitation (Billion cubic meter)
Intensive pastures	14	557	51.5
Average pastures	60	214	79.3

Conclusion and discussion

Precipitation analysis on pastures of Iran

- Iran precipitation volume is about 420 billion cubic meters annually.
- About 130 billion cubic meters of this rainfalls is precipitated on intensive and average yielding pastures.
- Assuming 30% of such precipitation contributes to surface runoffs and groundwater resources (blue waters), about 90 billion cubic meters of this volume of water as green water is precipitated on the pastures and evapotranspired out of their surfaces.
- This is a considerable volume of water which should be monitored and managed. However, enough founds are not allocated for such development for pastures improvement.

Conclusion and discussion

Review on Iran water resources balance

- In Iran about 70% of annual precipitation is lost as direct evaporation or evapotranspiration from vegetation which is excluded from the government planning process.
- About 30% of precipitation (130 billion cubic meters of renewable water) remains as available water (about 90 billion cubic meters in form of surface run off and about 40 billion cubic meters in form of groundwater resources) for further use.
- It is mentioning that 70% (about 290 billion cubic meters per year) water losses expressed in the national water balance is not totally lost by evaporation. Some major parts of that returns to the atmosphere through transpiration from the pastures, forests and rain-fed agricultural.
- This part (green water) contributes to the chain of consumption, hence to the gross national products (GNP).
- Most of Iranian officials and planners exclude this volume of water and disregard its potential impacts in economy. It is necessary to bring the concept of green water within the national water balance of Iran in any related water planning consideration.

Conclusion and discussion

The green water impacts on national pastures production

Index	Intensive pastures	medium pastures	Irrigated wheat	Rain-fed wheat
Area (Million hectare)	14	60	204	402
Productivity (Kg/ha)	290	92	3650	1050
Total annual production (Million ton)	203	505	807	405
Total annual precipitation after subtracting water runoff and ground water recharge (Billion cubic meter)	36	5505	702	1205
Ratio of production efficiency to water consumption (Cubic meter of one kilogram raw matter or WP)	15.6	11.1	0.8	2.8

Conclusion and discussion

The green water impacts on national pastures production

- Forage production in natural pastures using green water compare to rain-fed grain production shows considerable economical potential by upgrading the use of green water in pastures.
- Water productivity in pastures compare to irrigated and rain-fed agriculture is very low.
- In irrigated and rain-fed agriculture for producing one kilogram dry matter on average about 1.2 cubic meter of water is used.

Conclusion and discussion

The green water impacts on national pastures production

- While in pastures for producing one kilogram dry matter on average about 11-15 cubic meter water is used. It should be noted that only a little part of this water is used in the production cycle, while major part of such rain water evaporates from the bare land.

- Compare to rain-fed dry matter production in the two categories of pastures, production are about 9% and 28%, respectively.

Conclusion and discussion

Production performance of pastures (PPP) in various scenarios

Scenario	Index	Intensive	Average pastures
Existing situation	Total annual production (Million ton)	203	505
	Performance (kg/ha)	290	92
	Ratio of PPP to the production performance of rain- fed areas (PPP)	28	9
Optimum situation	Total annual production (Mmillion ton)	12	33
	Performance (kg/ha)	857	550
	Ratio of PPP to	80	50
50% and 20% situation	Total annual production (Mmillion ton)	7	13
	Performance (kg/ha)	525	210
	Ratio of PPP to PPR	50	25

Conclusion and discussion

Production performance of pastures (PPP) in various scenarios

- Management improvement will bring production enhancement in medium and intensive pastures.
- In case of optimum pasture management the pastures production may rise to 50% and 80%, respectively.
- By proper investment and performing suitable pasture management, it is expected that medium pastures at least produce 50% of rain-fed agriculture or about 33 million ton dry matter of hay and intensive pastures will yield 80% of the rain-fed agriculture or about 12 million ton dry matter of hay.
- In this scenario, the existing total production of medium and intensive pastures from less than 8 million tons shall increase to 45 million tons in the optimum scenario.

Conclusion and discussion

Production performance of pastures (PPP) in various scenarios

- In more conservative scenario (scenario of 50% and 20% situation), production in intensive pastures may reach to 50% of average rain-fed agriculture (from 290 k/ha at present reaches 525 k/ha in future) and production of medium pastures may reach 20% of dry farming (from 92 k/ha may increase to 210 k/ha).

- In this case, production of intensive pastures in dry matter hay shall reach about 7 million tons of hay and that of the medium pastures shall increase to 13 million tons.

Conclusion and discussion

Existing volume of water in Iran pastures for hay production cycle

(Billion cubic meter)

Scenario/ situation	Intensive pastures	Average pastures	total
Existing	2	6	8
Optimum	12	33	45
50% & 20%	7	13	20

Considering the irrigated agricultural productivity (using more than one cubic meter water for producing of one kilogram dry matter on average), the corresponding volume of water in so consumed by pastures in the existing situation, optimum situation, and 50% and 20% scenario are 8, 45 and 20 billion cubic meter, respectively.

Conclusion and discussion

Existing volume of water in Iran pastures for hay production cycle

- At the present in Iran, total allocated water for about 1.3 million ha of existing modern irrigation networks is about 10 billion cubic meters.
- Even with performing a moderate pasture management in 50% and 20% scenario, about 20 billion cubic meters of new water resources shall be contributed to the production cycle.
- This volume of water is approximately equal to the volume of water in the production cycle of Iran controlled by existing dams for irrigation purposes.
- It should be noticed that such volume of 20 and/or 45 billion cubic meters of water in the case of optimum pastures management is not part of 130 billion cubic meters of the renewable water assumed in National Water Balance of the country.

Conclusion and discussion

Economic value of water consumed in pastures

Average cost of water in Iran water structures on the basis of 2009 prices (Rials per cubic meters, 12000 Rials = 1USD, Based on IWRCM)

At the dam site	At the diversion dam	At the main irrigation distribution system	At the farm
600	800	1300	1800

As rainfall irrigate at the pastures directly, so the value of consumed water would be equal to 1800 Rials according to the cost of providing irrigation water at farm.

Conclusion and discussion

Economic value of water consumed in pastures

Economic value of water in the production cycle of pastures in the base year of 2009 (1000 billion Rials)

Structure/scenario	Existing situation	Optimum scenario	50% and 20% scenario
At the dam site	4.2	27	12
At the diversion dam	7.2	36	16
At the main irrigation distribution system	10.4	58.5	26
At the farm	14.4	81	36

Conclusion and discussion

Economic value of water consumed in pastures

- In the scenario of 50% and 20%, about 36000 billion Rials per year is estimated for the total value of water in the production cycle of the pastures which is considerable.
- The value of pastures is not only related to the production hay, forage, or supply of livestock food, but also has a lot of other utilizations such as prevention of soil erosion, floods control, watershed management, prevention of sedimentation in dams, supplying groundwater resources, supplying ecosystem water, etc.
- According to the assessment of IFPO, only 25% of the pastures value is related to the production of hay, forage, and livestock rising, and the other 75% is related to above - mentioned advantages.

Conclusion and discussion

Economic value of water consumed in pastures

- IFPO has announced that the monetary value of the total Iran pastures production per year is about 200000 billion Rials.
- The maximum annual budget allocated for pastures management and improvement is 60 billion Rials. This figure is equal to only 0.03% of the annual production value of pastures.
- IFPO allocates 1000 Rials for each ha at the present situation for operation and maintenance of pastures.
- For perfect pastures management and obtaining optimum yield, a budget of 15 million Rials should be invested for each hectare.

Conclusion

- The economic values of green water management which used by pastures were discussed.
- The other consideration such as social and environmental issues, employment potential, soil protection, livestock grazing and meat production have not been touched in this study.
- The results of this study demonstrated that Iran water resources policy makers are required to review and improve their approaches on macro - policies.
- It was shown that the total volume of water involved in the production cycle of the pastures in the optimum scenario is more than the total volume of water controlled by dams in Iran.

Conclusion

- At the present situation and without any extra cost, the total volume of water in the production cycle of the pastures is equal to the total volume of water released to modern irrigation networks in the country.
- It is recommended that proper pasture management with the required budget allocation should be considered in the future government agenda.
- Considering the green water in Iran as a part of water resources of the country is suggested.
- Receive proper attention to the green water at least equal to the status of blue water, is suggested.


Thank you for attention
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