Participatory adaptation of hot pepper (Capsicum species) varieties for green pod production under irrigation condition

Reducing Land Degradation and Farmers' Vulnerability to Climate Change in the Highland Dry Areas of North-Western Ethiopia

TECHNICAL REPORT OF EXPERIMENTAL ACTIVITIES

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Implemented by

ICARDA
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Cover foto: Participatory pepper variety selection with involvement of farmers | April 2014 | Photo by Asmamaw Bidru

About ICARDA

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Synthesis

Activity type: Technology generation

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Summary Report

The present situation in North Gondar Zone indicates that, there are limited Capsicum species and varieties including both improved and the local ones. As a result, varietal information for the improvement of the crop for high fruit yield and quality in the existing agro-ecology is insufficient. There has also been limited research and development effort on developing, adapting, demonstrating and disseminating of improved hot pepper technologies. Evaluating the adaptability of improved hot pepper varieties which enables the growers to select the best performing varieties in the study area should be conducted getting priority.

This experiment was initiated in the framework of the research project 'Reducing land degradation and farmers' vulnerability to climate change in the highland dry areas of North-Western Ethiopia', to help small producers to achieve sustainable production and fair access to pepper markets in order to increase their income and secure their livelihood by providing adaptable and high yielding varieties. The objective of this experiment was to evaluate the performance of some hot pepper varieties for green pod yield and quality under irrigation condition and to recommend best adapting and high yielding varieties for the farmers in the study area. The adaptation trial was conducted at Gumara-Maksegnit water shade area in 2014/15 under irrigation condition.

In total, six hot pepper varieties were evaluated for quality green pod production using randomized complete block design with three replications under irrigation condition. Farmers were participated in selection of varieties. Varieties marko fana, Indam-10 and Indam-42 were the best performing pepper varieties in terms of green pod yield compared to other varieties. Marko fana outperformed the other hot pepper varieties in terms of green pod yield. Generally, Indam 10 and Indam 42 were early maturing, high number pods producing varieties as well as best performing varieties in terms of green pod yield performing. However, theses varieties are characterized by narrower in diameter and shorter in length which fails to meet the best green pod market quality requirement. Melka Eshet and Melka Zala had higher pod length but gave lower yield. Marko fana had wider pod diameter and gave better yield than other varieties. In terms of green pod yield Marko Fana, Indam 10 and Indam 42 were the best performing varieties. Due to diseases infestation all hot pepper varieties did not give best green pod yield and their green pod yield performance were much less compared to when released as well as the crop yield potential.

Schematic summary of information

Location:	Dogola Chinchaye village, Gumara-Maksegnit watershed, Gondar
Easting:	03°45'59.1"
Northing:	13°73'24.9"
Elevation:	1978m a.s.l.
Period of implementation:	October, 2014 to June 2015
Duration of trials:	One year
Activity leader(s):	Asmamaw Bidru E-mail: asmamawbidru@yahoo.com
Other researchers involved:	Azeze Wubie

1 Background and rationale

Hot pepper (*Capsicum species*) belongs to the Family *Solanaceae*, Genus *Capsicum*, and species *frutescence* L., group of vegetables. Cultivated peppers are all members of the world capsicum species. In Ethiopia, different pepper types such as bell (sweet) pepper which is non-pungent, chili (mitimita) and hot pepper (berbere) which is pungent are produced in which hot pepper is dominantly produced. Capsicum peppers are commercially classified by the concentration of *capsaicin* ($C_{18}H_{27}O_3N$) which determines a variety's pungency.

Hot pepper (*capsicum*) is one of the major high value vegetable crops (also used as spice) produced in Ethiopia and the country is one of a few developing countries that have been producing paprika and capsicum oleoresins for domestic and export market. Because of its wide use in Ethiopian diet, the hot pepper is an important traditional crop mainly valued for its pungency and color in the form of karia (*green pod*) and berbere (*dry pod in ground powder*). The crop is also one of the important spice cash crops that serve as the source of income particularly for smallholder producers in many parts of the country. The main producing areas in the country are the central (Eastern and Southern Shoa), Western, North Western (Wellega, Gojjam) and the Northern part.

Capsicum is grown in different agro-ecological areas in which hot pepper predominates. Small scale farmers in various regions especially in Southern and Western Ethiopia extensively produce it. The fruits are consumed as fresh, dried or processes products as vegetable and as a spices.

In spite of its importance, the hot pepper productivity for green and dry pod has stayed low compared to the crop yield potential and world average yield. In the Amhara region,

60,801.45 t dry and 2,118.72 t green hot pepper were produced with average productivity of 2.04 and 9.02 t ha -1 respectively (CSA, 2011). According to FAO (2009) on the other hand, world average green pepper productivity, was 15.5 t/ha which shows hot pepper productivity in Amhara region is far below the world average. Whereas improved hot pepper varieties released by the national research institute have given 1.8-2.5 t/ha dried pepper and 15 - 20 t/ha green pepper at research stations (Gebremeskel et al., 2015; Simon and Tesfaye, 2014; Lema et al., 2008). Different research and development works can be done in order to narrow the yield including evaluating different improved hot pepper varieties for adaptation. The decline of hot pepper production is also attributed mainly to lack of improved, good quality and well adapted varieties, poor agronomic practices, poor disease and pest management (Fekadu and Dandena, 2006; Alemu and Ermias, 2000).

A number of varieties (Melka Awaze, Melkashote, Mareko fana, Bako local, Melka Zala, Melka dima, and Melka eshete) have been released so far for fresh and dry market by Ethiopian Institute of Agricultural Research (EIAR) (MoARD, 2009) although, their adaptation and suitability for different agro-ecologies of the country has not been determined fully. A study which was carried out under irrigation condition at Raya valley showed that the highest marketable, unmarketable and total yield was produced at Melka awaze(352.6) and Mareko fana (317.5) varieties (Gebremeskel et al., 2015).

In North Gondar Zone, hot pepper is a major spice and vegetable crop produced by the farmers. There is therefore a strong need to help small producers to achieve sustainable production and fair access to pepper markets in order to increase their income and secure their livelihood by providing adaptable and high yielding varieties.

The present situation indicates that in North Gondar Zone there are limited Capsicum species and varieties including both improved and the local ones. As a result, varietal information for the improvement of the crop for high fruit yield and quality in the existing agro-ecology is insufficient. There has also been limited research and development effort on developing, adapting, demonstrating and disseminating of improved hot pepper technologies. Evaluation of selected varieties is therefore one of the primary considerations to ease the existing problems of obtaining the desired varieties. In order to combine the agronomical performance of varieties with farmer's preference, participatory varietal selection approach has been used (Ceccarelli et al. 1996).

2 Objectives

The main objectives of this research activity were to evaluate the performance of some hot pepper varieties for green pod yield and quality under irrigation condition and to recommend best adapting and high yielding varieties for the farmers in the study area.

3 Experimental Methods

Nursery beds were prepared on October 23, 2014. Seeds of all varieties were sown on 25th October, 2014 at Gondar Zuria woreda nursery site on seed bed size of 1x10m having 15 cm rows apart. Beds were covered with dry grass after sowing. Up to the seedlings reached for transplanting it had been covered by raised shade to protect it from strong sun shine. It was watering every day with a fine meshed sprinkler. The plot size was 2.8m*3m (total size 8.4m2) with 4 rows on each plot. Healthy and uniformly grown seedlings were selected, and transplanted to the experimental field after attaining the 4-5 leaf stage. Transplanting was done 45 days after sowing on 10th December, 2014 and the seedlings were planted at a spacing of 70cm*30cm inter- and intra-row spacing, respectively. There were 10 plants per row and totally 40 plants per plot. Data were collected from the middle 20 plants from the central two rows per plot.

Fertilizer was applied at a rate of 200kg/ha DAP and 100kg/ha Urea. Urea was applied by split application method, half at planting and half at flowering. It was irrigated using furrow irrigation method. It had been irrigated in 3 days' interval until the seedlings were established very well. Then the irrigation interval was extended to once per a week. All other agronomic practices were carried out uniformly in all plots. Chemical was not sprayed to control pests. Harvesting was conducted 2-3 times depending on growth.

4 Statistical aspects

Treatments:

Four released (Melka Eshete, Melkawaze MelkaZala, and Marekofana) and two introduced (Indam 10 and Indam 42) varieties were evaluated for green pod production under irrigation condition.

Statistical design: the treatments were arranged in a randomized complete block design with six varieties (treatments) and three replications per variety.

Response variables: the response variables measured were stand count at harvesting, Plant height (cm), Days to 50% flowering, Days to pod development, Days to pod maturity, Pod length (cm), Number of branches per plant, Pod diameter (cm), Number of pod per plant, Marketable yield (Q/ha), Unmarketable (Q/ha), Total yield (Q/ha) and Pest & Disease Incidence (%) were collected and analyzed.

Variables	unit of measure	determination method
stand count at harvesting	No	Counting
Plant height	*Cm*	*Measuring tape*
Days to 50% flowering,	*Day*	*Counting*
Days to pod development	*Day*	*Counting*
Days to pod maturity	*Day*	*Counting*
Pod length	*Cm*	*Counting*
Number of branches per plant	*No*	*Counting*
Pod diameter	*Cm*	*Caliber*
Number of pod per plant	*No*	*No*
Marketable yield	*Tone/ha*	*Scale*
Unmarketable	*Tone/ha*	*Scale*
Total yield	*Tone/ha*	*Scale*
Powdery mildew Incidence	*Percent*	*Percent*

Statistical analysis: for each response variable, ANOVA mean separation procedure were carried out. The Least Significant Difference (LSD) test was used to compare the mean separations at $P<0.05$. The Data were analyzed using SAS 9.0. Farmers' selection data were analyzed using simple ranking method in accordance with the given value The ranking procedure was explained for farmer participants and then each selection criterion was ranked from 1 to 3 (1= very good, 2= medium, and 3= poor) for each variety (De Boef and Thijssen, 2007).

5 Results

Green pod yield and yield related traits

Due to diseases infestation all hot pepper varieties did not give best green pod yield and their green pod yield performance were much less compared to when released as well as the crop yield potential. Varieties melka eshet, marko fana, melka awaze and melka zala were confirmed to give the average marketable green pod yield of 15 - 20 t/ha in research condition (lemma et al., 2008). However, all tested varieties have given lower green pod yield (table 1) than the national average green pod productivity of 9.02 ton/ha (CSA, 2011).

The analysis of variance table revealed that there was significant statistical difference ($p<0.05$) for all variables except number of branches per plant (table 1). Generally, Indam 10 and Indam 42 were early maturing, high number pods producing varieties as well as best performing varieties in terms of green pod yield performing. However, these varieties are characterized by narrower in diameter and shorter in length which fails to

meet the best green pod market quality requirement. Melka Eshet and Melka Zala had higher pod length but gave lower yield. Marko fana had wider pod diameter and gave better yield than other varieties. In terms of green pod yield Marko Fana, Indam 10 and Indam 42 were the best performing varieties (table 1).

A group of farmers have selected marko fana the best performing variety followed by Melka Zala (table 2). In addition, according to the farmers' preference the following traits are very significant in hot pepper breeding in order of importance: Disease tolerance, pod weight, no of pods per plant, pod color, pod size, test, and pungency (table 3).

Table 1: Farmer's preference /selection

No.	Criteria	Varieties					
		Melka eshet	Marko fana	Melka awaze	Indam - 42	Indam -10	Melka zala
1	pungency	2	1	3	1	1	2
2	Pod size	3	1	2	3	3	2
3	Test	3	1	2	2	3	2
4	Color	3	1	3	3	3	2
5	Disease tolerance	2	1	2	3	3	1
6	No of pods per plant	2	2	3	1	1	3
7	Pod weight	3	1	3	3	3	2
	Sum	18	8	18	16	17	14
	Rank	5	1	5	3	4	2

Ranks 1= very good 2= medium 3= poor

Table 2: Farmer's preference for best traits in hot pepper variety for green pod yield

S/N	Criteria	1 Pungency	2 Pod size	3 Test	4 Pod color	5 Disease tolerance	6 No of pods per plant	7 Pod weight	Frequency	Rank
1	Pungency		2	3	4	5	6	7	0	7
2	Pod size			2	4	5	6	7	2	5
3	Test				3	5	6	7	2	6
4	Pod color					5	6	7	2	4
5	Disease tolerance						5	5	6	1
6	No of pods per plant							7	4	3
7	Pod weight								6	2

Table 3: Mean of green pod yield and yield related traits

Varieties	Days to flowering	Days to pod development	Days to pod maturity	Plant height (cm)	No of pod /plant	No of branches /plant	Pod length (cm)	Pod diameter (cm)	Marketable yield (ton/ha)	Unmarketable (ton/ha)	Total yield (ton/ha)	Powedery mildew incidence (%)
Melka Eshet	79^{a}	104^{a}	130^{a}	55.3^{b}	18.9^{bc}	4.5	19.9^{b}	0.93^{d}	2.47^{bc}	0.12^{b}	2.58^{bc}	81.67^{b}
Marko Fana	70^{b}	90^{c}	120^{b}	62.6^{a}	11.9^{cd}	4.1	10.0^{d}	2.1^{a}	4.15^{a}	0.19^{a}	4.35^{a}	79.33^{bc}
Melka Awaze	78^{a}	97^{b}	129^{a}	64.7^{a}	18.3^{bcd}	4.4	9.6^{d}	1.3^{b}	2.49^{bc}	0.16^{ab}	2.64^{bc}	81.67^{b}
Indam -42	62^{c}	86^{d}	113^{c}	48.4^{bc}	23.8^{ab}	4.2	10.2^{d}	1.1^{cd}	3.58^{ab}	0.17^{a}	3.75^{ab}	95.00^{a}
Indam -10	59^{c}	81^{e}	106^{d}	42.5^{c}	30.0^{a}	3.8	12.2^{c}	1.03^{cd}	3.76^{ab}	0.20^{a}	3.96^{ab}	95.0^{a}
Melka Zala	79^{a}	105^{a}	131^{a}	63.5^{a}	9.0^{d}	4.0	21.9^{a}	1.2^{cb}	1.66^{c}	0.07^{c}	1.73^{c}	76.67^{c}
Mean	71	94	121	56.18	18.0	4.2	13.9	1.28	3.04	0,15	3.19	84.88
CV	2.12	0.66	1.6	7.06	14.42	13.8	5.63	9.77	17.12	15.64	16.21	2.55
2.76	1.13	3.56	7.22	4.72	1.04	1.43	0.23	0.946	0.043	0.942	3.95	2.76

6 Special issues raised

Powdery mildew (*Leveillula taurica*) was the main disease occurred, resulting in defoliation and very low yields. All plots had greater than 75% infestation (average 85%). Particularly, early maturing hot pepper varieties (Indam-10 and Indam-42) were highly affected by powdery mildew. On the underside of leaves all varieties, white powdery spores were developed. Severely infected plants were dropped off their leaves.

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***NOTE**: The data presented in this report are currently being elaborated for scientific publication, thus some of them are not final. The aim of this report is to summarize the nature and quality of the activities conducted and of the dataset generated, and to illustrate the main results obtained.*

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